

**Fermi National Accelerator Laboratory**

**D0 Engineering Note #XXX**

**Mapping of Fibers from the Detector  
to the CFT Axial Front End Cards  
through to the Digital Boards**

**Note: Color is used within this document. If printing, a color  
printer is recommended.**

**John T. Anderson**

**Available on-line at**

**<http://d0server1/users/janderson/Public~1/default.html>**

**And**

**<http://d0server1/users/janderson/Public~1/a990208b.doc>**

<b>1. INTRODUCTION .....</b>	<b>3</b>
<b>2. SYSTEM OVERVIEW.....</b>	<b>3</b>
<b>3. FIBER GEOMETRY – NAMING CONVENTION .....</b>	<b>4</b>
<b>4. ROUTING OF FIBERS FROM THE DETECTOR TO THE CASSETTE.....</b>	<b>5</b>
<b>5. ROUTING WITHIN THE CASSETTE.....</b>	<b>6</b>
<b>6. ROUTING WITHIN THE ANALOG FRONT END BOARD .....</b>	<b>10</b>
<b>7. DETAILED WARM END FIBER MAP.....</b>	<b>13</b>
<b>8. CHARGE SIGNAL HANDLING AND SVX READOUT WITHIN THE ANALOG FRONT END BOARD .....</b>	<b>21</b>
<b>9. MAPPING OF FIBERS INTO THE DIGITAL FRONT END BOARDS.....</b>	<b>30</b>
<b>10. TIME MULTIPLEXING OF FIBER DATA ONTO SERIAL LINKS .....</b>	<b>48</b>
10.1. LEFT-HANDED FIBER ORDER.....	49
10.2. RIGHT-HANDED ORDER .....	51
10.3. STATUS AND SYNCHRONIZATION INFORMATION.....	53

***Table of Figures***

FIGURE 1 – FIBER NUMBERING CONVENTION.....	4
FIGURE 2 – CASSETTE WARM END FIBER CONNECTOR NUMBERING CONVENTION .....	5
FIGURE 3 – SCHEMATIC VIEW OF ROUTING WITHIN CASSETTE.....	6
FIGURE 4 – TOP VIEW OF CASSETTE .....	7
FIGURE 5 – VLPC CONNECTION MAP AT COLD END.....	8
FIGURE 6 – COMPONENT SIDE VIEW OF CIN:APSE CONNECTOR PAD PATTERN.....	8
FIGURE 7 – READOUT MAP OF CASSETTE .....	10
FIGURE 8 – READOUT ORDER AT CASSETTE WARM END .....	11
FIGURE 9 – MCM ORIENTATION DIAGRAM .....	12
FIGURE 10 – WARM END OPTICAL CONNECTOR #1 .....	13
FIGURE 11 – WARM END OPTICAL CONNECTOR #2 .....	14
FIGURE 12 – WARM END OPTICAL CONNECTOR #3 .....	15
FIGURE 13 – WARM END OPTICAL CONNECTOR #4 .....	16
FIGURE 14 – WARM END OPTICAL CONNECTOR #5 .....	17
FIGURE 15 – WARM END OPTICAL CONNECTOR #6 .....	18
FIGURE 16 – WARM END OPTICAL CONNECTOR #7 .....	19
FIGURE 17– WARM END OPTICAL CONNECTOR #8 .....	20

## 1. Introduction

This document analyzes the routing of fibers from the CFT Axial detector layers to the Front End analog cards of the CFT detector. A routing scheme is detailed which allows for the design of a single, 'non-handed', Front End card layout which can be used as either the 'right-handed' or 'left-handed' board in a VLPC cassette. The path of the fibers through the Front End boards to the Digital Boards is then detailed.

## 2. System Overview

The CFT system consists of a set of 8 concentric cylinders of optical fiber arranged in layers. Each of these layers has 'axial' fibers, that is, those which run parallel to the beam direction. The 360 degrees of rotation around this axis have been broken into 80 'sectors', each of which spans 4.5 degrees. Each Front End board is connected to one sector's worth of fibers. Two boards make up a 'cassette', which views a total of 1024 fibers. The mechanical design of the cassette requires that the two boards be on opposite sides; part height clearances require that both boards face 'away' from the centerline of the cassette. This has resulted in the concept of 'right-handed' and 'left-handed' boards, indicative of the direction in which the components protrude away from the cassette centerline when viewed from the front. Analysis of the Front End boards has resulted in the realization that a single 'non-handed' design – that is, a single layout which can be used in both orientations- is possible, so long as certain minor restrictions in the fiber placement at the top of the cassette are observed.

Each successive layer of fibers from innermost ('A') to outermost ('H') has more fibers than the last; in addition, an eighth layer of Preshower ('PS') fibers exists outside the H layer. Preshower fibers are larger than the axial fibers; there are relatively few PS fibers per sector, but triggering requirements force a different circuit design for PS fibers as opposed to axial fibers. Every PS fiber is measured twice, at two different thresholds; also, the thresholds associated with the PS fibers are sufficiently different from the axial fibers that the entire PS circuit must be independent of any axial fiber circuit. This places limits on the distribution of fibers into the Front End boards.

All the data from the Front End boards is sent to Digital Boards by high-speed serial data links. There is a single Digital Board for every pair of Front End boards. These Digital Boards take the bit pattern of which fibers were above or below threshold to find particle tracks. To make sure no tracks are missed, some fibers from each sector of the detector must be made available to the neighboring sector to close the 'cracks'. To obtain sufficient bandwidth, each Front End board must drive four digital links to a given Digital Board. Each Digital board receives 10 links, to allow all data from a pair of sectors (one cassette) to be processed, plus some fibers from adjoining cassettes.

A detailed analysis of these links is provided in Jamieson Olsen's engineering note #990105A, available on the Internet at <http://d0server1.fnal.gov/users/jamieson/www/notes/990105a.pdf>.

This document traverses this entire system and describes each of the physical data links in detail:

- Fiber run from detector to top of cassette
- Signal run from top of cassette to input of Front End board
- Signal processing from input of Front End board to Digital Board links
- Breakdown of which fibers are transmitted across which Digital Board link at which times

### 3. Fiber Geometry – Naming Convention

Before beginning with fiber connection maps, a common reference of fiber names is required. Figure 1 shows a pair of sectors, with color and number annotations for every axial fiber and preshower fiber within that sector pair. Thanks to Jamieson Olsen for the nice picture. The colors are indicative of which high-speed Front End to Digital Board link will carry the fiber's information.

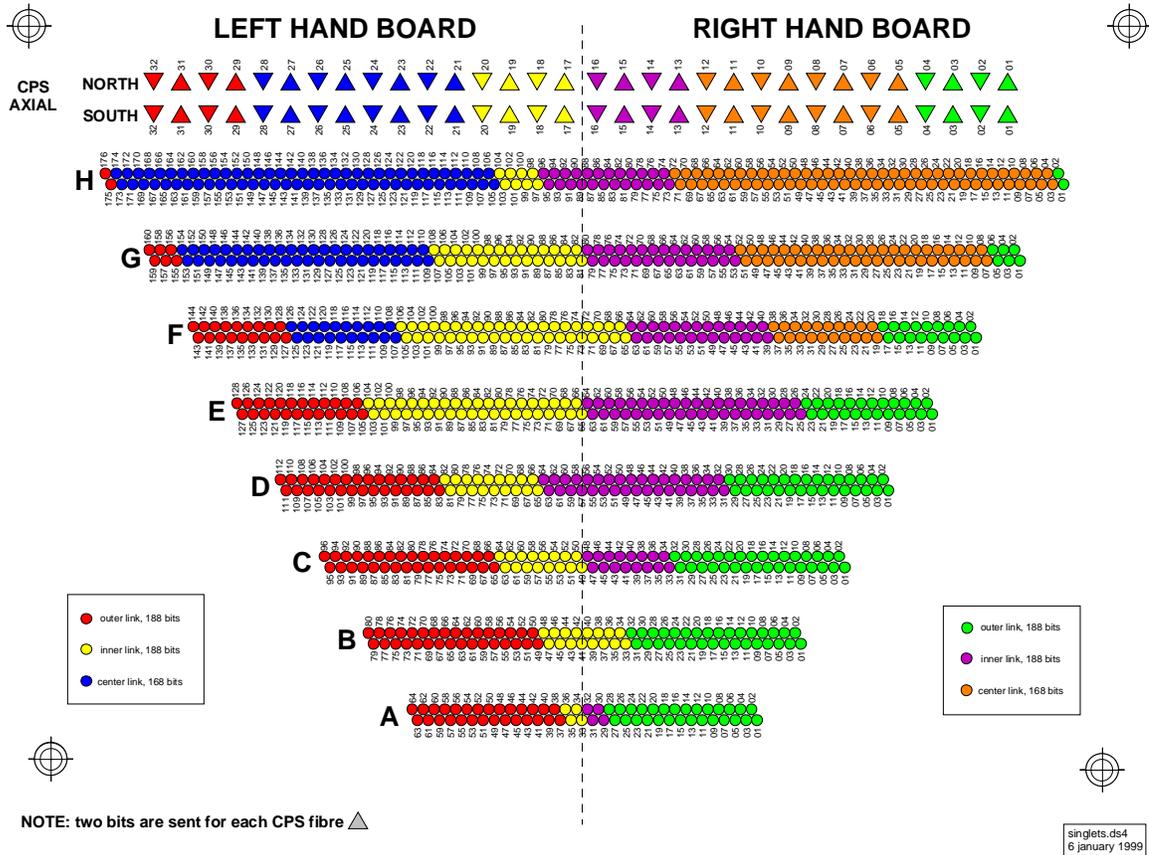


Figure 1 – Fiber Numbering Convention

For the moment the color may be ignored; however, note that each fiber may now be referenced as the layer letter designation followed by the fiber number, which is unique per sector pair and increases with the phi angle of the detector (e.g. A27, G58, PSN5, PSS8, C59...; the fiber numbers increase in this view from right to left in all layers, with number 1 being the lower right fiber, #2 the upper right, #3 just left of #1, etc. in all cases). The color becomes important when considering how the data moves from the Front End Boards to the Digital Boards. The drawing shows two 'rows' in each layer indicative of the 'singlet' fibers; triggering people will recall that in the trigger logic, an even-numbered and the adjacent odd-numbered fiber in each layer are combined into a 'doublet' and this is what's used for track finding.

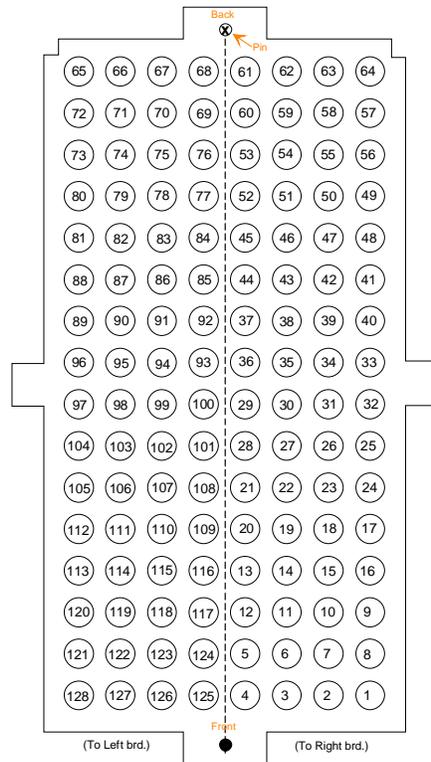
Because of the architecture where two Front End boards drive a single Digital Board, the numbering scheme must span *two* sectors in order to keep the signals straight all the way through. Therefore, instead of thinking about 80 sectors in the detector, it is far better to think about 40 *sector pairs* – that is, all the fibers which land in one cassette make up one *pair*. Throughout this note, the *pairwise* number convention is used.

## 4. Routing of Fibers from the Detector to the Cassette

Armed with a naming convention for the fibers within the sector, we may then proceed to trace from the detector to the warm end, or top, of the cassette. A couple of restrictions are immediately applicable:

- To enable the 'non-handed' design, the Preshower fibers will have to end up in the middle of the cassette. Preshower fibers are treated differently than the rest of the axial fibers in the Front End circuitry, and so the relative position of the preshower fibers should not change with the orientation of the board.
- The fibers at the cassette top should be grouped into obvious groups of sixteen to best map into the fiber mixing boxes that convert from fiber ribbons in the detector.

Each individual Warm End fiber connector at the top of the cassette has 128 connection points. To facilitate the routing of the individual fibers from the detector to the cassettes, these points at the cassette top need be numbered. A magnified view of one of the Warm End fiber connectors is given in Figure 2, which also indicates the numbering scheme applied within this connector. Note that the connector is polarized via two small cutouts are at the rear of the connector. In addition, a pin at the rear and a hole at the front insure both alignment and polarization. The 'front' of the cassette is towards the *bottom* of this drawing, which is looking down from the top of the cassette.

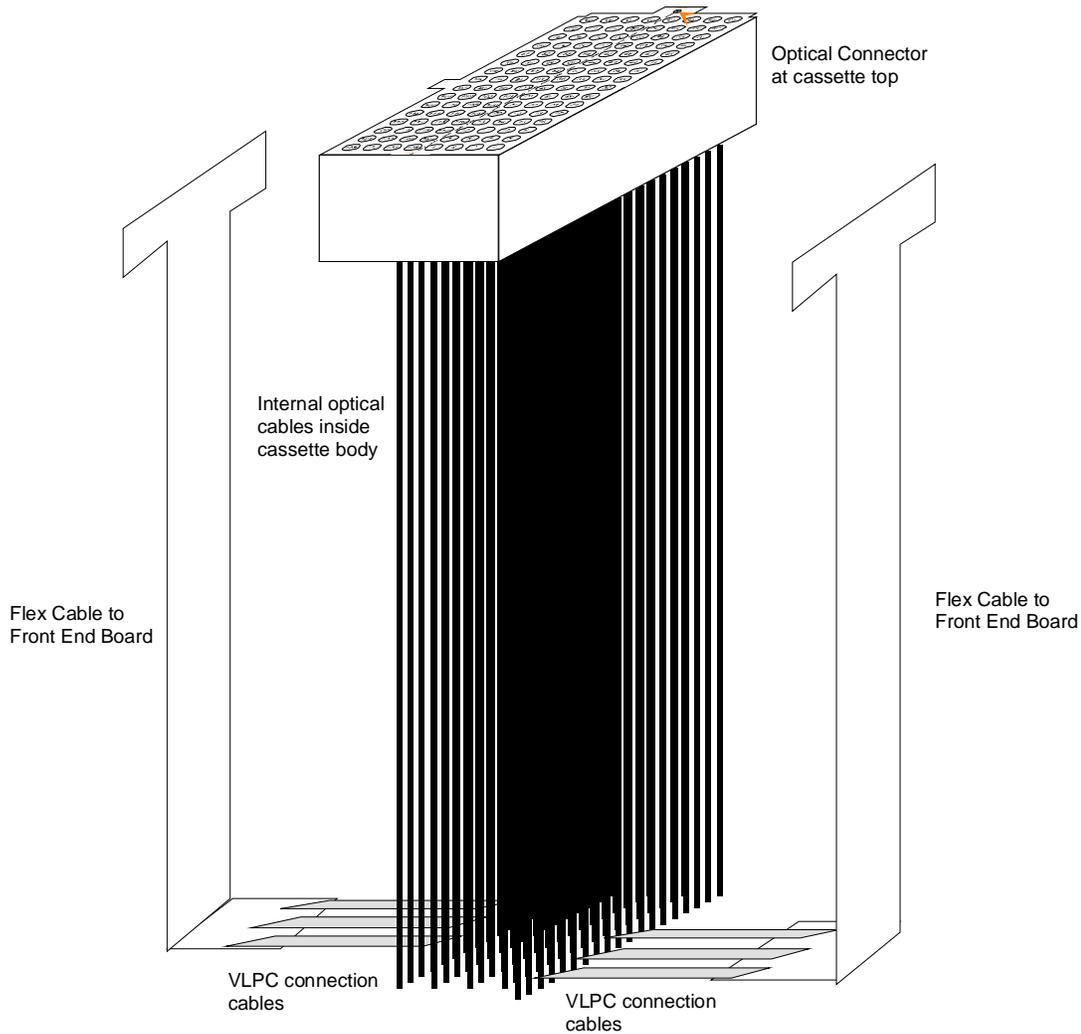


**Figure 2 – Cassette Warm End Fiber Connector Numbering Convention**

Eight of these Warm End connectors are present at the top of the cassette. To uniquely identify every fiber connection, the connectors are themselves numbered from 1 to 8, with #1 being the connector closest to the front of the cassette and #8 being the rearmost. Any given fiber connection point is thus named **m-n**; for example, fiber connection #1-1 is the front-most, right-most connection point on the front-most connector, and connection #8-65 is the rear-most, left-most connection point on the rear-most connector.

## 5. Routing within the Cassette

Once the fibers are landed in the Warm End connector, the signal traverses the internal fibers in the body of the cassette until landing at the VLPC circuits. A small circuit board connects the VLPC circuits to a Flex Cable. This Flex Cable then connects to the Cin:Apse connectors on the Front End board. This path is shown schematically in Figure 3.



**Figure 3 – Schematic View of Routing within Cassette**

The cassette provides mechanical mounting for the two Front End boards in addition to routing the fiber signals from the top end to the photosensitive electronics mounted at the bottom (cold) end. The photoelectronics converts the optical signals to small currents which are routed up through a flexible circuit to the Front End boards. The routing path through the VLPC connection cables and the Flex Circuits results in a mapping between the fiber optic connector pinout and the pinout of the Cin:Apse connectors on the Front End boards. There is a correspondence in that each Cin:apse connector mates only to signals from a single connector at the cassette top; however, the Cin:Apse connector also contains extra pins which correspond to VLPC control signals. All totaled, 64 fiber signals are added to VLPC signals to fill up the 80-pin Cin:apse connector.

Again, there are eight Cin:Apse connectors on each of the Front End boards, and so these pins are numbered **m-n**, where 'm' is which Cin:Apse connector and 'n' is the pin within that connector.

The 'non-handed' board design, however, plays into the numbering scheme at this juncture. Since the same printed circuit board layout is being used for both the 'left-hand' and the 'right-hand' board, the numbering of the Cin:Apse connectors must be referenced to the *pc board*, and not to the orientation of the connector within the cassette. The Cin:apse connector which is in the left-most position when the board is being viewed from its component side is Cin:Apse #1, and the numbers increase as one scans from left edge to right edge of the board as viewed from the component side.

This is a critical observation; a moment's pause will show that Cin:Apse connector #1 maps to cassette connector #1 when the board is inserted in the 'right-hand' side of the cassette, but Cin:Apse #1 maps to optical connector #8 when the board is inserted in the 'left-hand' side. Figure 4 shows a foreshortened top view of the cassette highlighting this connector mapping.

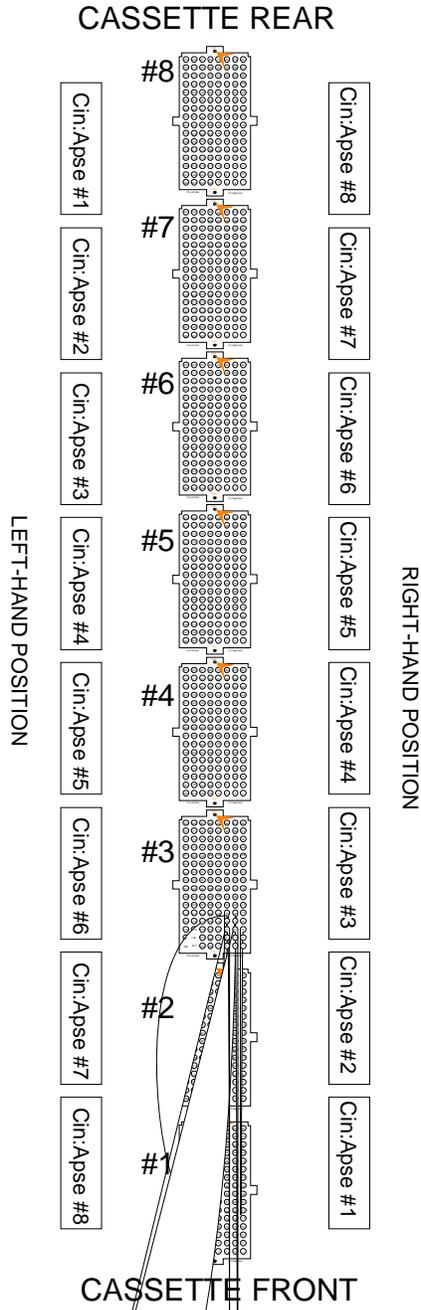


Figure 4 – Top View of Cassette



Optical connector position (LH insertion)	Cin:Apse pin on board	Optical connector position (RH insertion)
128	80	64
127	79	63
126	81	62
125	82	61
124	74	60
123	75	59
122	77	58
121	76	57
120	71	56
119	70	55
118	72	54
117	73	53
116	65	52
115	66	51
114	68	50
113	67	49
112	62	48
111	61	47
110	63	46
109	64	45
108	56	44
107	57	43
106	59	42
105	58	41
104	53	40
103	52	39
102	54	38
101	55	37
100	47	36
99	48	35
98	50	34
97	49	33

Optical connector position (LH insertion)	Cin:Apse pin on board	Optical connector position (RH insertion)
96	43	32
95	44	31
94	45	30
93	46	29
92	37	28
91	40	27
90	42	26
89	39	25
88	36	24
87	33	23
86	35	22
85	38	21
84	30	20
83	29	19
82	31	18
81	32	17
80	25	16
79	26	15
78	28	14
77	27	13
76	19	12
75	22	11
74	24	10
73	21	9
72	18	8
71	15	7
70	17	6
69	20	5
68	12	4
67	11	3
66	13	2
65	14	1

**Table 1**

## 6. Routing Within the Analog Front End Board

In the Front End board, eight Multi-Chip Modules (MCMs) receive the data from the eight Warm End optical connections. Each MCM has 72 inputs. One MCM must be reserved in full for use with the 32 Preshower channels (16 Preshower North, or PSN, and 16 Preshower South, or PSS) which land on a board. Each of the Preshower channels is charge split and actually drives 64 MCM inputs. Because of the different levels of charge generated by Preshower fibers as opposed to the axial fibers, the thresholds in the Preshower MCM are very different from those of the other MCMs.

In addition, one would like the readout of the SVX data in the MCMs to correspond reasonably to the detector geometry. Combining these two requirements, Figure 7 shows how the fibers in general can be routed to the cassette's warm end such that the SVX readout, the preshower centering and the preshower's exclusive use of one MCM may be accommodated. The basic idea is that the readout order goes in terms of increasing pin number along the cassette top connectors, and also lays out such that the readout goes from lower-numbered to higher-numbered pins in the Cin:ap:se connectors, which corresponds to increasing channel numbers in the SVX chips inside the MCMs.

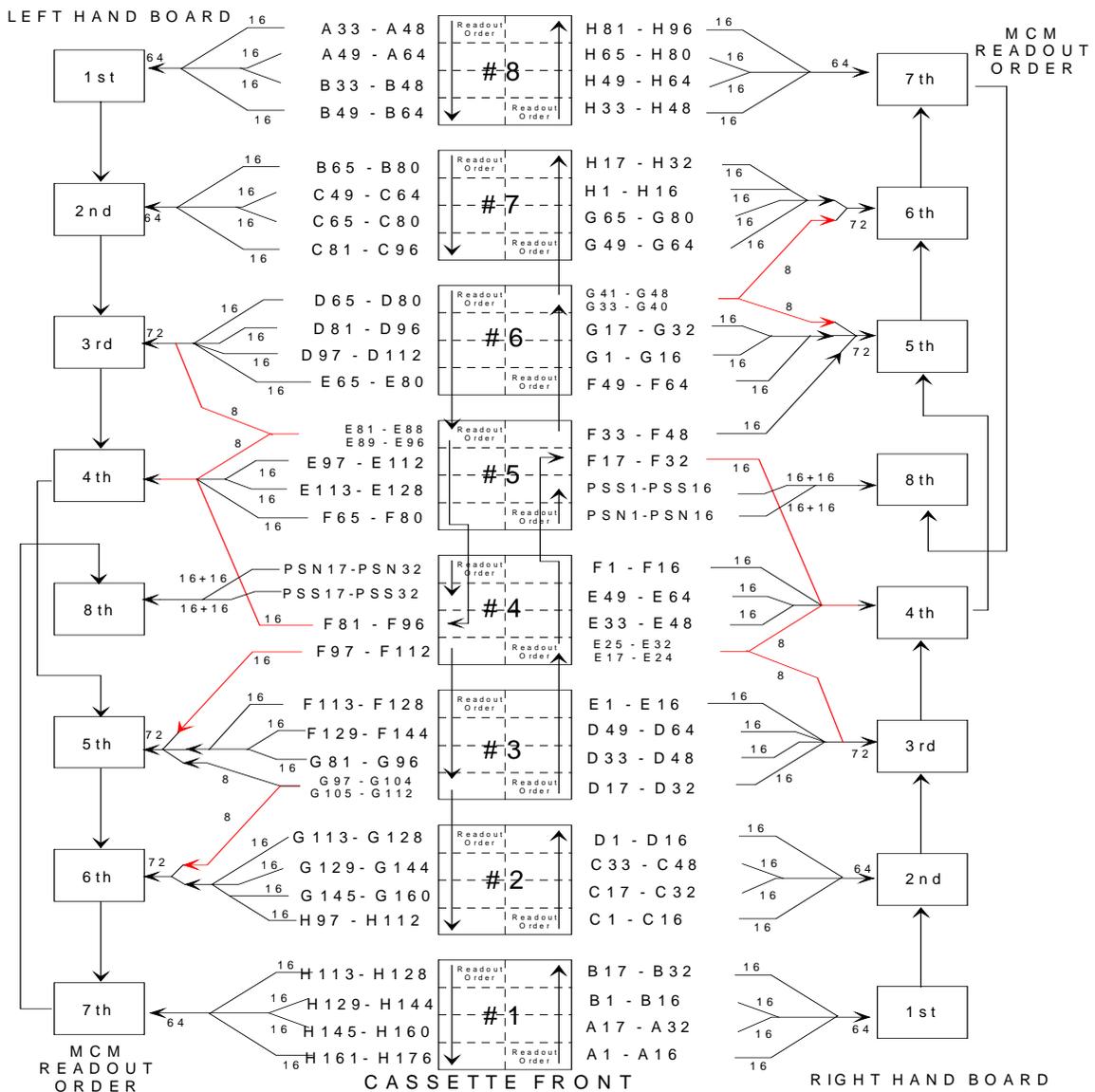


Figure 7 – Readout map of Cassette

There's an awful lot of information in Figure 7, so some discussion of it is useful. The eight boxes along the center column represent the eight warm end fiber optic connectors. The dashed lines within those boxes indicate groups of sixteen fibers. The column of boxes at the far left and far right represent the MCMs on the Front End board, in both 'left-hand' and 'right-hand' insertions. The MCM boxes are connected by arrows which indicate the order of data readout to level 3 – that is, the desired SVX readout order. Trigger outputs are not shown in this diagram. For comparison purposes, the same 'readout order' arrows are redrawn within the warm end connectors, showing how the readout scans through the fibers from that perspective. The order as given provides a 'raster scan' readout of the sector from the 'A' layer through to the 'H' layer, followed by the preshower signals.

Along the optical connectors on both sides are names of fibers (including preshower) which are placed in each group of sixteen optical connections. Note that the preshower fibers are placed such that if the 'left-hand' layout is rotated 180 degrees to create the 'right-hand' layout, the preshower fibers PSx17-PSx32 are in the same relative position to the Front End board as are fibers PSx1-PSx16. This only works if the preshower fibers are routed to the middle connectors (#4 and #5). Once the preshowers are placed, the remaining fibers are simply grouped by layer and number to fill out the connector in order. As shown the 'A' layer is completely read out followed by the 'B', 'C', 'D', etc. with the 'H' layer and preshower at the end. Figure 8 below graphically shows the readout order across one warm end fiber optic connector.

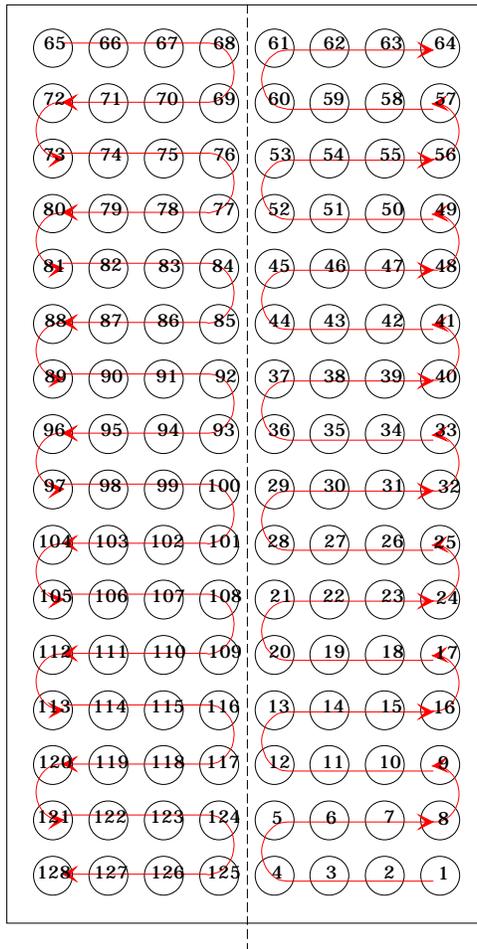
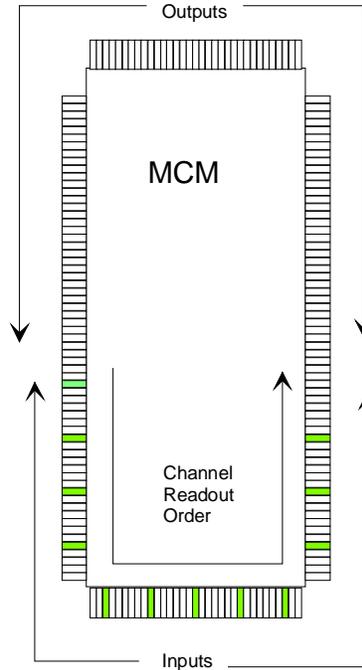


Figure 8 – Readout Order at Cassette Warm End

The arrows within Figure 7 show how the various fibers map back into the MCMs on the board. Some MCMs have only 64 of 72 inputs driven, whereas others use all 72. The red arrows indicate signals that come in on a given Cin:Apse connector but have to route to the MCM physically adjacent to the neighboring Cin:Apse connector; these signals may have slightly degraded noise characteristics and certainly require special care in PCB layout. After going through all the twists, the order of readout ends up proceeding from the lower-numbered pins of the Cin:Apse connector towards the higher-numbered pins.

The left-to-right flow of the readout in the Cin:Apse connector matches well with the layout of the MCM, where the input pins are located along three sides of the part. Lower-numbered channels (which are first to be read out of the SVX during Level 3 readout) are at the left, and the highest-numbered channels are located at the right, as shown in Figure 9.



**Figure 9 – MCM Orientation Diagram**

Because of the way the VLPC board maps to the Flex Cable, the readout is *not* in monotonic order. The precise readout order of the Front End board may be derived from combining Figure 7 and Table 1. To complete the analysis, the data presented by the fibers to the Front End board must also be mapped to the various high-speed digital links which run to the Digital Boards. The following section shows a graphical breakdown of the information summarized in Figure 7. After that, the analysis of the way the information travels from Front End to Digital Board is presented.

## 7. Detailed Warm End Fiber Map

Armed with the algorithm detailed above, drawings may be generated for each of the eight warm end connectors, showing the fibers that plug into each position. Figures 10 through 17 show a top view of each of the eight warm end connectors. Within each picture the grey text indicates the Warm End pin number; the black number indicates the fiber plugged into that pin.

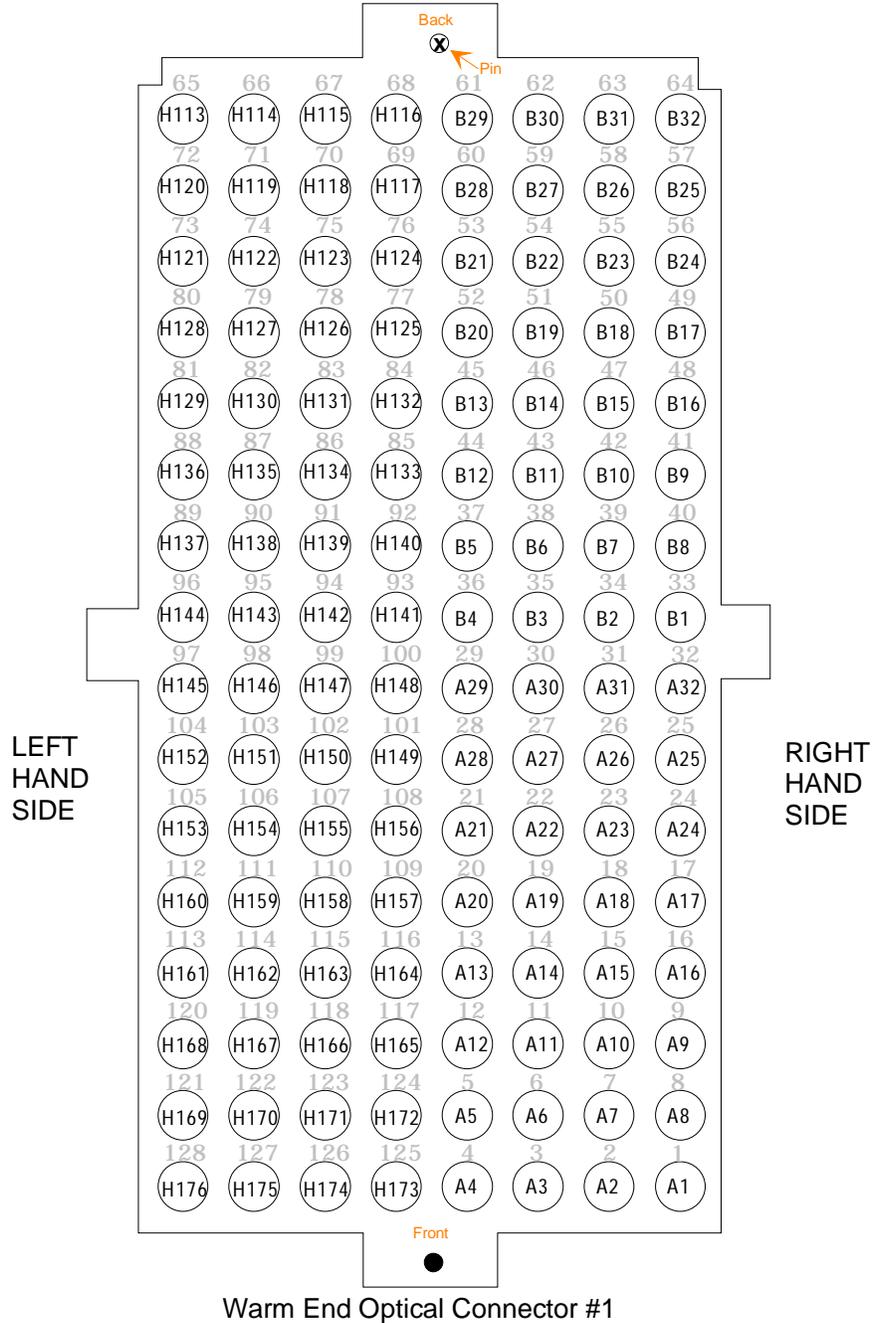
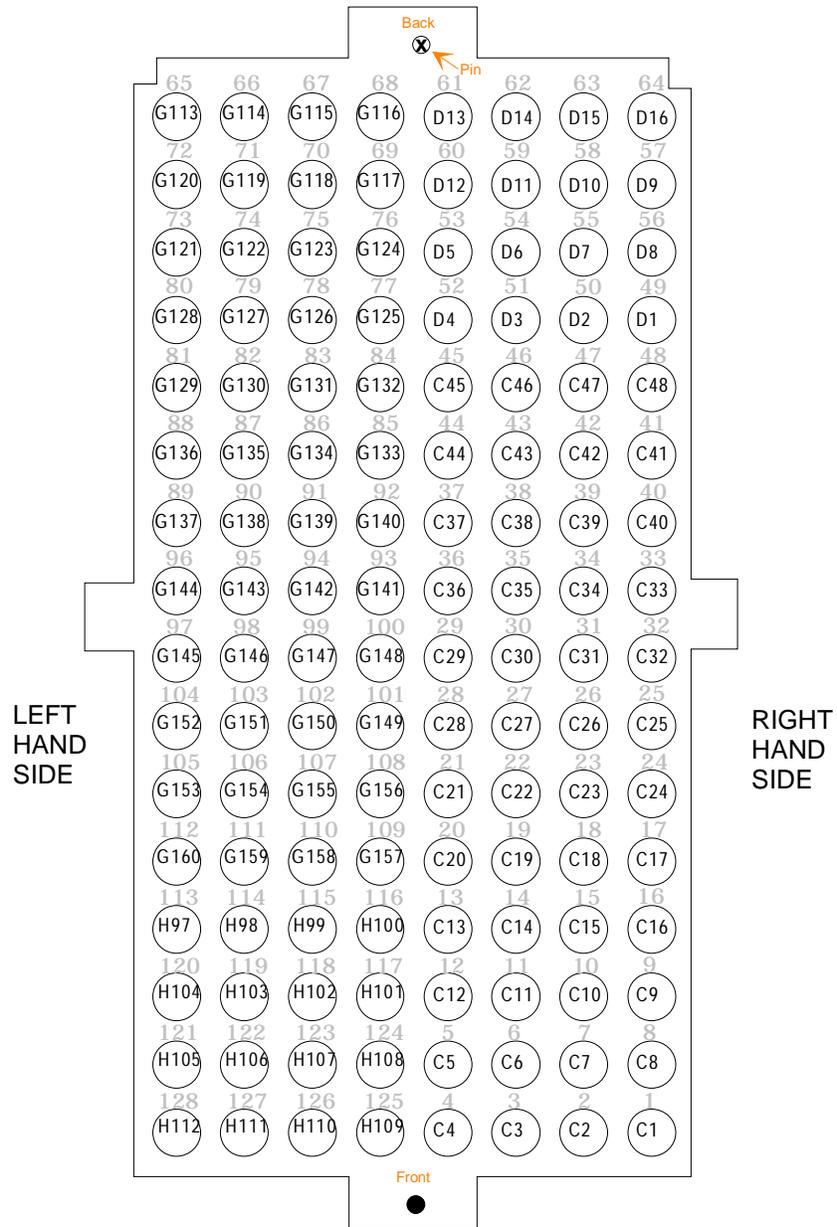
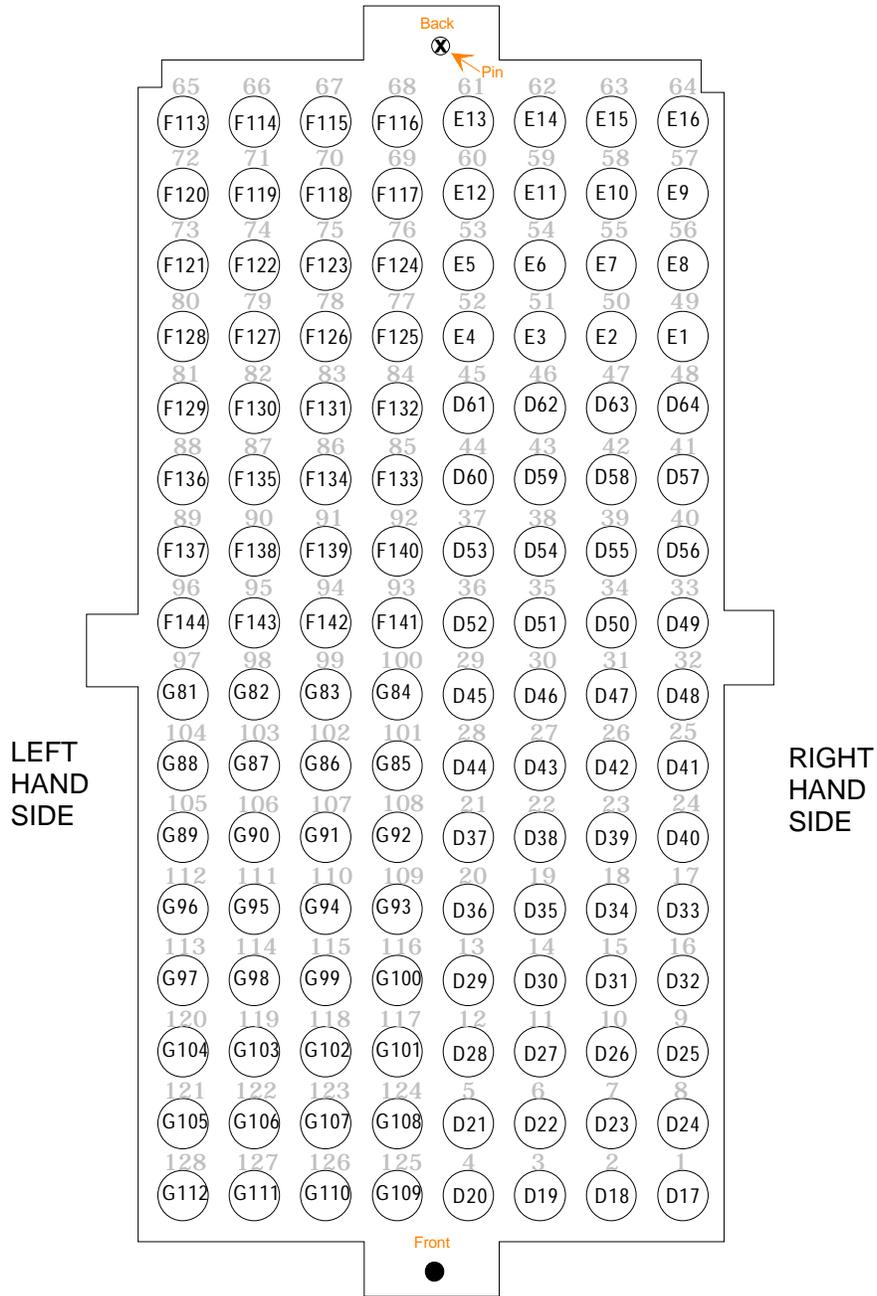


Figure 10 – Warm End Optical Connector #1



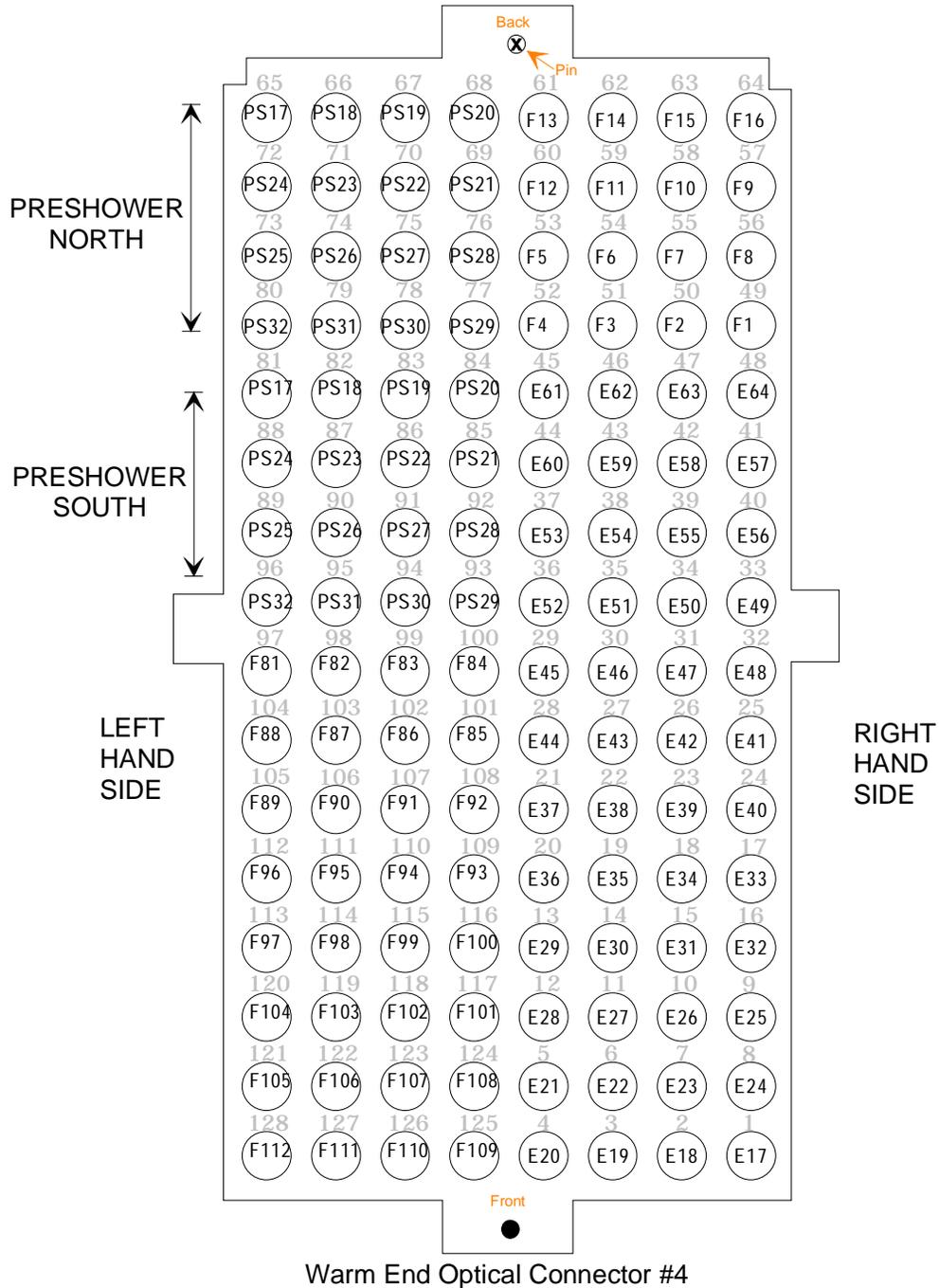
Warm End Optical Connector #2

**Figure 11 – Warm End Optical Connector #2**



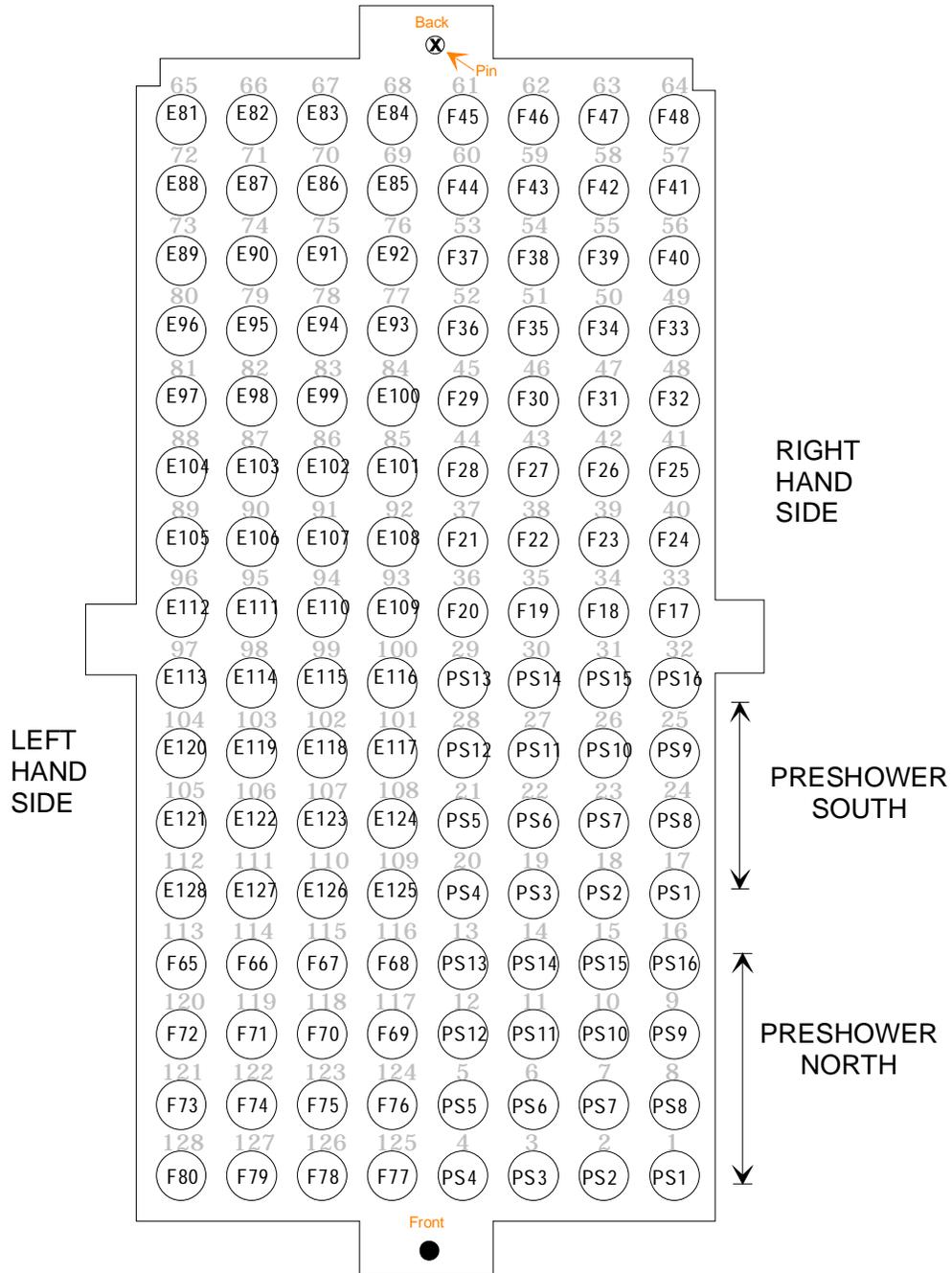
Warm End Optical Connector #3

Figure 12 – Warm End Optical Connector #3



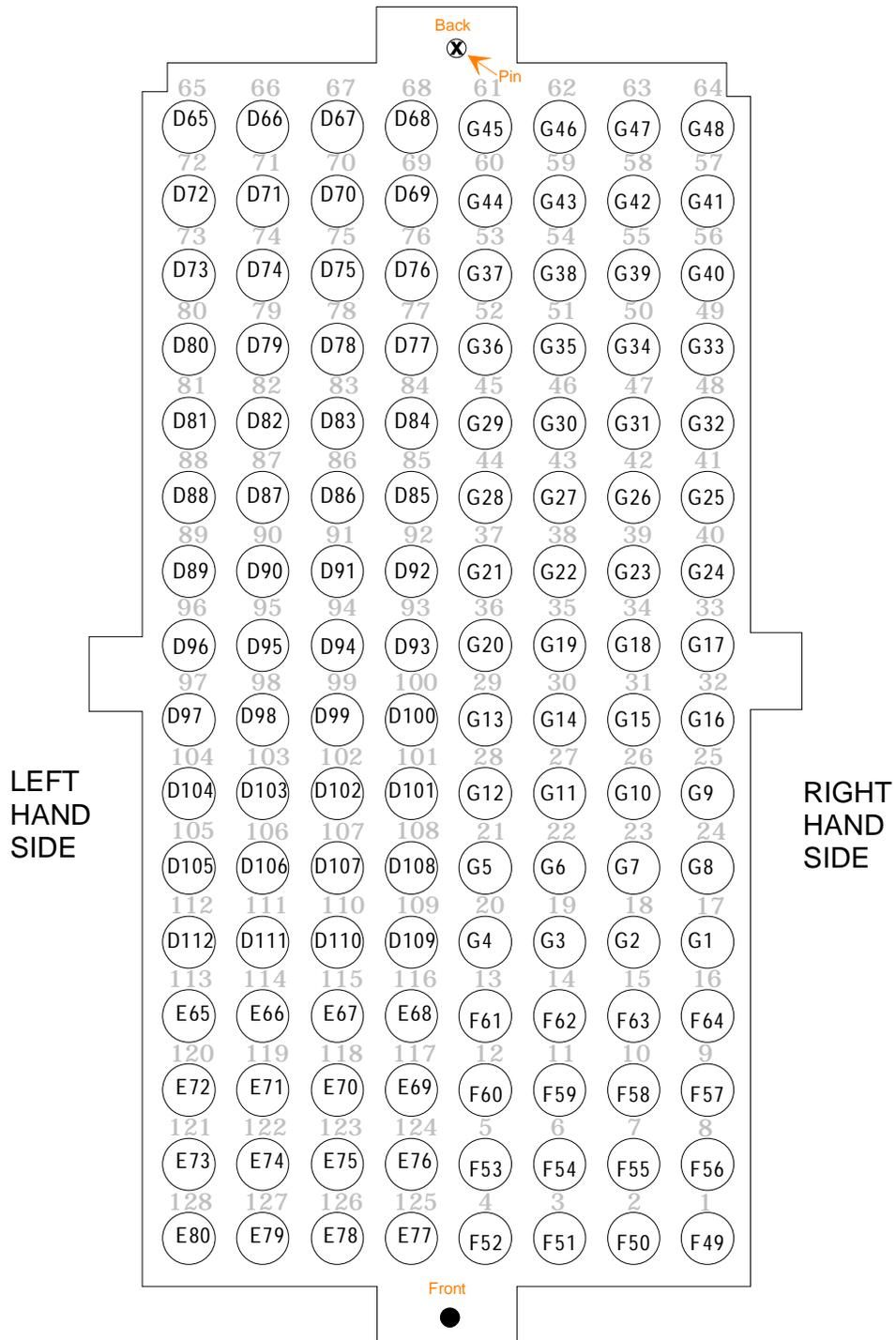
**Figure 13 – Warm End Optical Connector #4**

Note the preshower fibers routed into connector #4. The other half of the preshower is routed to connector #5.

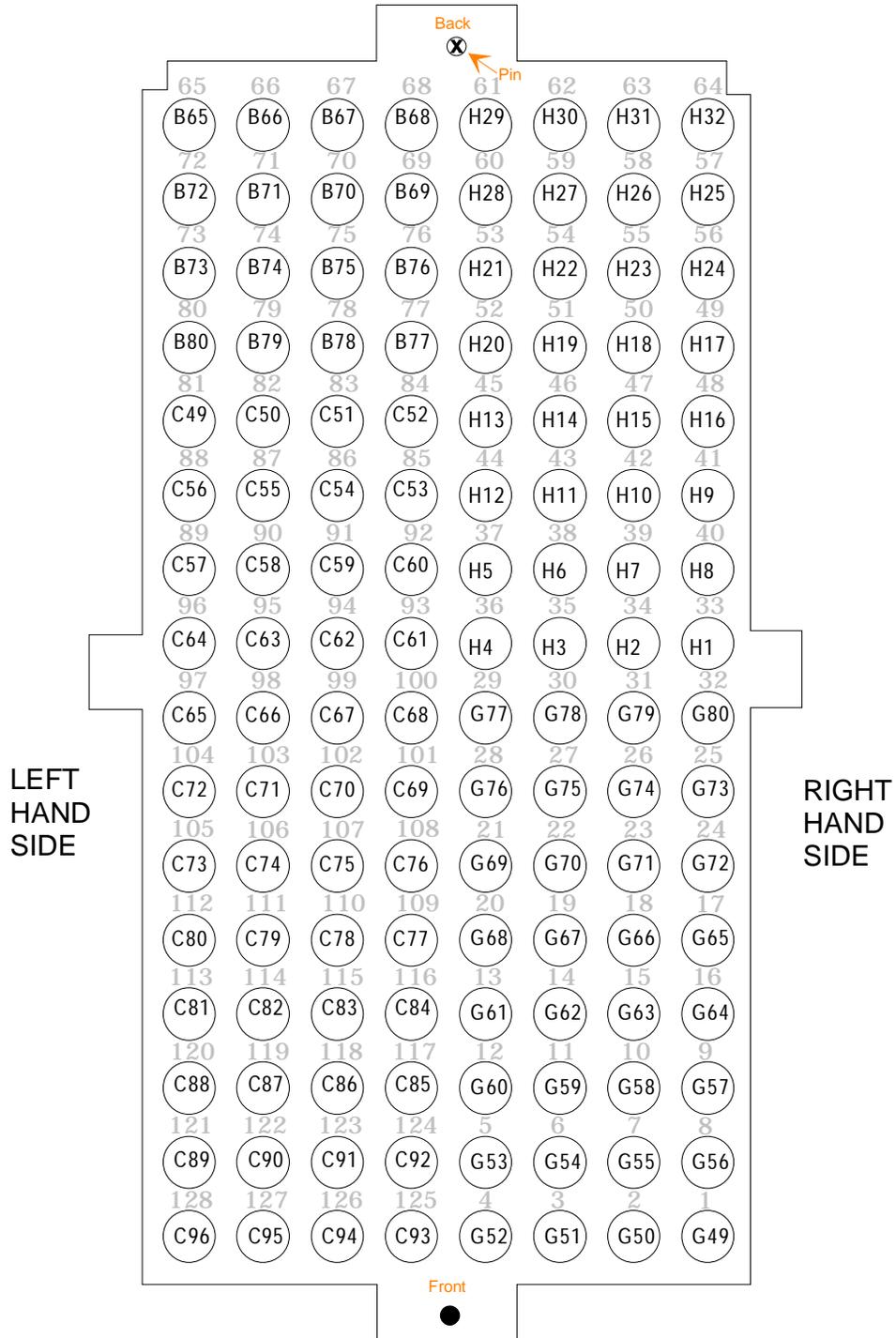


Warm End Optical Connector #5

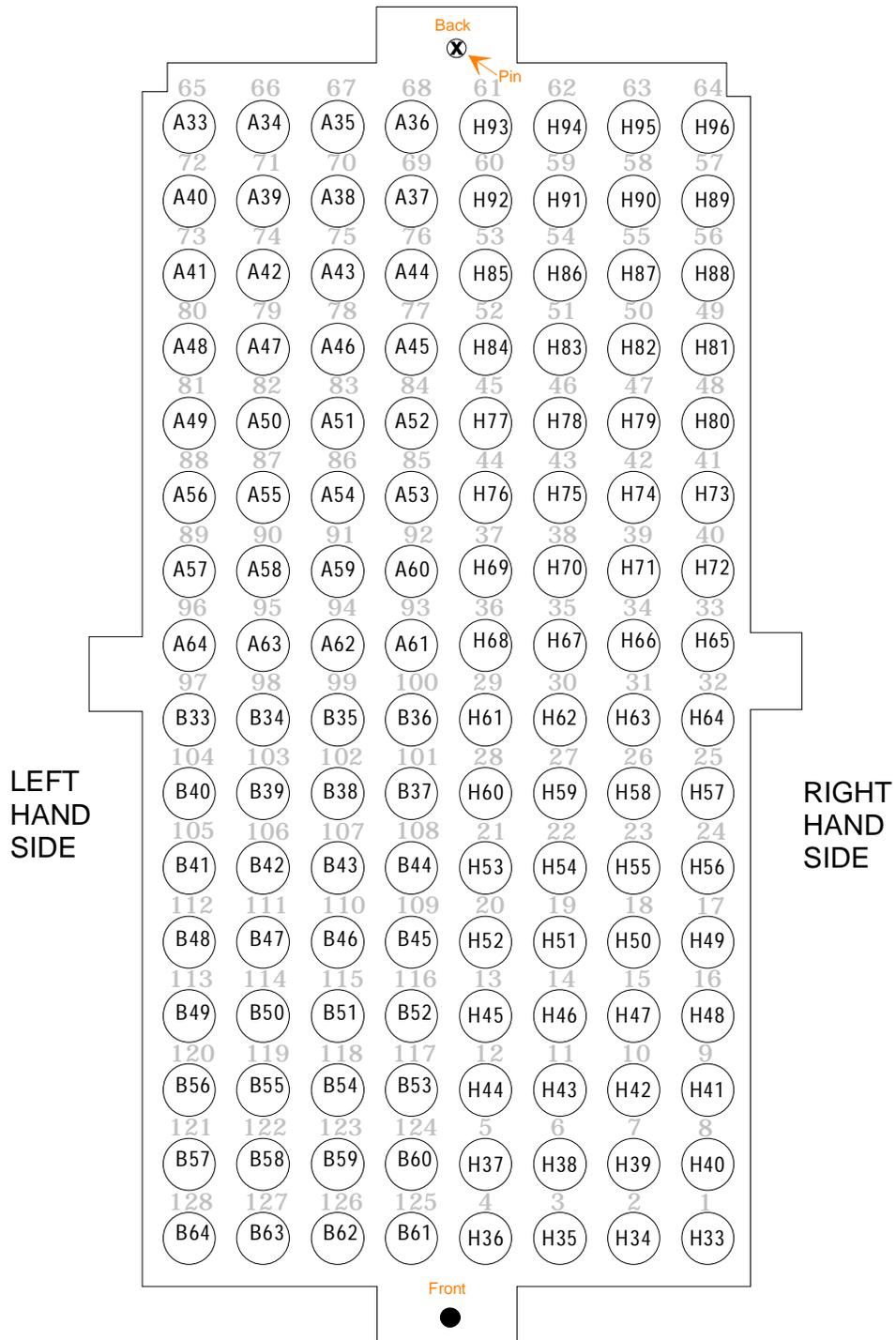
Figure 14 – Warm End Optical Connector #5



Warm End Optical Connector #6  
**Figure 15 – Warm End Optical Connector #6**



Warm End Optical Connector #7  
**Figure 16 – Warm End Optical Connector #7**



Warm End Optical Connector #8  
**Figure 17– Warm End Optical Connector #8**

## 8. Charge Signal Handling and SVX Readout Within the Analog Front End Board

Charge signals (that is, charge signals driven by the VLPCs in response to light from the fibers) land on eight Cin:apse connectors on the Front End analog boards. Each of these connectors services one or more MCM modules as shown back in Figure 7. The details of what happens in the Front End board are outside the purview of this document; however, to eliminate a point of confusion, the following must be made clear.

- Each Cin:apse connector delivers 64 channels of charge information to the Front End board, for a total of 512 charge signals.
- 32 of these charge signals (the Preshower signals) are split into two portions prior to digitization by the MCM, so instead of 512 bits of discriminator output, there are 544 bits. Each preshower fiber creates two discriminator output bits.
- Each MCM has 72 *possible* discriminator outputs, but only MCMs 3,4,5 & 6 use all 72 channels. MCMs 1,2,7 & 8 use only 64 of 72 inputs, resulting in 32 unused channels in the board. These 32 'extras' are reserved for diagnostic purposes and do not contribute to the normal readout of the board.

From the Level 2 and Level 3 software perspective, it is desirable to understand how the fibers read out in "SVX order". The information within Figure 7 shows the basic algorithm, but omits the exact details of which SVX channel is associated with each fiber of the sector pair. When the Front End board is read out by the SVX sequencer, each MCM in order is read out from MCM #1 to MCM #8. Within each MCM, the SVX chip reads out from the lowest-numbered channel towards the highest-numbered channel, but only those channels above threshold are actually reported.

The SVX chip itself has 128 channels, but within the MCM only 72 are connected – and they're not the first 72, but a selection of 72 out of 128, evenly scattered around the chip. Thus, the SVX channel number as reported during the L2 or L3 readout will not simply increment, but will have skips and jumps – both from the threshold selection and from the fact that not all the SVX channels in a chip are wired up.

Tables 2 through 9 show, for both the 'left-handed' and 'right-handed' insertions of the Front End board, which actual fiber of the sector pair (please reference Figure 1) is associated with each SVX channel. The Chip ID of the SVX readout pattern will indicate which MCM the data comes from; the data itself gives a channel number, which in combination with data from these tables, allows the user to reference a given SVX datum back to the fiber number from whence it came.

Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion	Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion
B64	MCM #1 - 118	B32	A64	MCM #1 - 62	A32
B63	MCM #1 - 117	B31	A63	MCM #1 - 59	A31
B62	MCM #1 - 114	B30	A62	MCM #1 - 58	A30
B61	MCM #1 - 113	B29	A61	MCM #1 - 57	A29
B60	MCM #1 - 110	B28	A60	MCM #1 - 56	A28
B59	MCM #1 - 109	B27	A59	MCM #1 - 53	A27
B58	MCM #1 - 108	B26	A58	MCM #1 - 52	A26
B57	MCM #1 - 107	B25	A57	MCM #1 - 49	A25
B56	MCM #1 - 104	B24	A56	MCM #1 - 48	A24
B55	MCM #1 - 103	B23	A55	MCM #1 - 47	A23
B54	MCM #1 - 102	B22	A54	MCM #1 - 46	A22
B53	MCM #1 - 99	B21	A53	MCM #1 - 43	A21
B52	MCM #1 - 98	B20	A52	MCM #1 - 42	A20
B51	MCM #1 - 97	B19	A51	MCM #1 - 41	A19
B50	MCM #1 - 94	B18	A50	MCM #1 - 38	A18
B49	MCM #1 - 92	B17	A49	MCM #1 - 37	A17
B48	MCM #1 - 91	B16	A48	MCM #1 - 36	A16
B47	MCM #1 - 88	B15	A47	MCM #1 - 32	A15
B46	MCM #1 - 87	B14	A46	MCM #1 - 29	A14
B45	MCM #1 - 84	B13	A45	MCM #1 - 28	A13
B44	MCM #1 - 83	B12	A44	MCM #1 - 27	A12
B43	MCM #1 - 82	B11	A43	MCM #1 - 26	A11
B42	MCM #1 - 81	B10	A42	MCM #1 - 23	A10
B41	MCM #1 - 78	B9	A41	MCM #1 - 22	A9
B40	MCM #1 - 77	B8	A40	MCM #1 - 21	A8
B39	MCM #1 - 74	B7	A39	MCM #1 - 20	A7
B38	MCM #1 - 73	B6	A38	MCM #1 - 17	A6
B37	MCM #1 - 72	B5	A37	MCM #1 - 16	A5
B36	MCM #1 - 71	B4	A36	MCM #1 - 13	A4
B35	MCM #1 - 68	B3	A35	MCM #1 - 12	A3
B34	MCM #1 - 67	B2	A34	MCM #1 - 11	A2
B33	MCM #1 - 66	B1	A33	MCM #1 - 10	A1

**Table 2**

Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion	Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion
B65	MCM #2 - 010	C1	C65	MCM #2 - 066	C33
B66	MCM #2 - 011	C2	C66	MCM #2 - 067	C34
B67	MCM #2 - 012	C3	C67	MCM #2 - 068	C35
B68	MCM #2 - 013	C4	C68	MCM #2 - 071	C36
B69	MCM #2 - 016	C5	C69	MCM #2 - 072	C37
B70	MCM #2 - 017	C6	C70	MCM #2 - 073	C38
B71	MCM #2 - 020	C7	C71	MCM #2 - 074	C39
B72	MCM #2 - 021	C8	C72	MCM #2 - 077	C40
B73	MCM #2 - 022	C9	C73	MCM #2 - 078	C41
B74	MCM #2 - 023	C10	C74	MCM #2 - 081	C42
B75	MCM #2 - 026	C11	C75	MCM #2 - 082	C43
B76	MCM #2 - 027	C12	C76	MCM #2 - 083	C44
B77	MCM #2 - 028	C13	C77	MCM #2 - 084	C45
B78	MCM #2 - 029	C14	C78	MCM #2 - 087	C46
B79	MCM #2 - 032	C15	C79	MCM #2 - 088	C47
B80	MCM #2 - 036	C16	C80	MCM #2 - 091	C48
C49	MCM #2 - 037	C17	C81	MCM #2 - 092	D1
C50	MCM #2 - 038	C18	C82	MCM #2 - 094	D2
C51	MCM #2 - 041	C19	C83	MCM #2 - 097	D3
C52	MCM #2 - 042	C20	C84	MCM #2 - 098	D4
C53	MCM #2 - 043	C21	C85	MCM #2 - 099	D5
C54	MCM #2 - 046	C22	C86	MCM #2 - 102	D6
C55	MCM #2 - 047	C23	C87	MCM #2 - 103	D7
C56	MCM #2 - 048	C24	C88	MCM #2 - 104	D8
C57	MCM #2 - 049	C25	C89	MCM #2 - 107	D9
C58	MCM #2 - 052	C26	C90	MCM #2 - 108	D10
C59	MCM #2 - 053	C27	C91	MCM #2 - 109	D11
C60	MCM #2 - 056	C28	C92	MCM #2 - 110	D12
C61	MCM #2 - 057	C29	C93	MCM #2 - 113	D13
C62	MCM #2 - 058	C30	C94	MCM #2 - 114	D14
C63	MCM #2 - 059	C31	C95	MCM #2 - 117	D15
C64	MCM #2 - 062	C32	C96	MCM #2 - 118	D16

**Table 3**

Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion	Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion
D65	MCM #3 - 002	D17	D101	MCM #3 - 066	D53
D66	MCM #3 - 005	D18	D102	MCM #3 - 067	D54
D67	MCM #3 - 006	D19	D103	MCM #3 - 068	D55
D68	MCM #3 - 007	D20	D104	MCM #3 - 071	D56
D69	MCM #3 - 010	D21	D105	MCM #3 - 072	D57
D70	MCM #3 - 011	D22	D106	MCM #3 - 073	D58
D71	MCM #3 - 012	D23	D107	MCM #3 - 074	D59
D72	MCM #3 - 013	D24	D108	MCM #3 - 077	D60
D73	MCM #3 - 016	D25	D109	MCM #3 - 078	D61
D74	MCM #3 - 017	D26	D110	MCM #3 - 081	D62
D75	MCM #3 - 020	D27	D111	MCM #3 - 082	D63
D76	MCM #3 - 021	D28	D112	MCM #3 - 083	D64
D77	MCM #3 - 022	D29	E65	MCM #3 - 084	E1
D78	MCM #3 - 023	D30	E66	MCM #3 - 087	E2
D79	MCM #3 - 026	D31	E67	MCM #3 - 088	E3
D80	MCM #3 - 027	D32	E68	MCM #3 - 091	E4
D81	MCM #3 - 028	D33	E69	MCM #3 - 092	E5
D82	MCM #3 - 029	D34	E70	MCM #3 - 094	E6
D83	MCM #3 - 032	D35	E71	MCM #3 - 097	E7
D84	MCM #3 - 036	D36	E72	MCM #3 - 098	E8
D85	MCM #3 - 037	D37	E73	MCM #3 - 099	E9
D86	MCM #3 - 038	D38	E74	MCM #3 - 102	E10
D87	MCM #3 - 041	D39	E75	MCM #3 - 103	E11
D88	MCM #3 - 042	D40	E76	MCM #3 - 104	E12
D89	MCM #3 - 043	D41	E77	MCM #3 - 107	E13
D90	MCM #3 - 046	D42	E78	MCM #3 - 108	E14
D91	MCM #3 - 047	D43	E79	MCM #3 - 109	E15
D92	MCM #3 - 048	D44	E80	MCM #3 - 110	E16
D93	MCM #3 - 049	D45	E81	MCM #3 - 113	E17
D94	MCM #3 - 052	D46	E82	MCM #3 - 114	E18
D95	MCM #3 - 053	D47	E83	MCM #3 - 117	E19
D96	MCM #3 - 056	D48	E84	MCM #3 - 118	E20
D97	MCM #3 - 057	D49	E85	MCM #3 - 119	E21
D98	MCM #3 - 058	D50	E86	MCM #3 - 120	E22
D99	MCM #3 - 059	D51	E87	MCM #3 - 123	E23
D100	MCM #3 - 062	D52	E88	MCM #3 - 124	E24

Table 4

Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion	Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion
E89	MCM #4 - 002	E25	E125	MCM #4 - 066	E61
E90	MCM #4 - 005	E26	E126	MCM #4 - 067	E62
E91	MCM #4 - 006	E27	E127	MCM #4 - 068	E63
E92	MCM #4 - 007	E28	E128	MCM #4 - 071	E64
E93	MCM #4 - 010	E29	F65	MCM #4 - 072	F1
E94	MCM #4 - 011	E30	F66	MCM #4 - 073	F2
E95	MCM #4 - 012	E31	F67	MCM #4 - 074	F3
E96	MCM #4 - 013	E32	F68	MCM #4 - 077	F4
E97	MCM #4 - 016	E33	F69	MCM #4 - 078	F5
E98	MCM #4 - 017	E34	F70	MCM #4 - 081	F6
E99	MCM #4 - 020	E35	F71	MCM #4 - 082	F7
E100	MCM #4 - 021	E36	F72	MCM #4 - 083	F8
E101	MCM #4 - 022	E37	F73	MCM #4 - 084	F9
E102	MCM #4 - 023	E38	F74	MCM #4 - 087	F10
E103	MCM #4 - 026	E39	F75	MCM #4 - 088	F11
E104	MCM #4 - 027	E40	F76	MCM #4 - 091	F12
E105	MCM #4 - 028	E41	F77	MCM #4 - 092	F13
E106	MCM #4 - 029	E42	F78	MCM #4 - 094	F14
E107	MCM #4 - 032	E43	F79	MCM #4 - 097	F15
E108	MCM #4 - 036	E44	F80	MCM #4 - 098	F16
E109	MCM #4 - 037	E45	F81	MCM #4 - 099	F17
E110	MCM #4 - 038	E46	F82	MCM #4 - 102	F18
E111	MCM #4 - 041	E47	F83	MCM #4 - 103	F19
E112	MCM #4 - 042	E48	F84	MCM #4 - 104	F20
E113	MCM #4 - 043	E49	F85	MCM #4 - 107	F21
E114	MCM #4 - 046	E50	F86	MCM #4 - 108	F22
E115	MCM #4 - 047	E51	F87	MCM #4 - 109	F23
E116	MCM #4 - 048	E52	F88	MCM #4 - 110	F24
E117	MCM #4 - 049	E53	F89	MCM #4 - 113	F25
E118	MCM #4 - 052	E54	F90	MCM #4 - 114	F26
E119	MCM #4 - 053	E55	F91	MCM #4 - 117	F27
E120	MCM #4 - 056	E56	F92	MCM #4 - 118	F28
E121	MCM #4 - 057	E57	F93	MCM #4 - 119	F29
E122	MCM #4 - 058	E58	F94	MCM #4 - 120	F30
E123	MCM #4 - 059	E59	F95	MCM #4 - 123	F31
E124	MCM #4 - 062	E60	F96	MCM #4 - 124	F32

Table 5

Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion	Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion
F97	MCM #5 - 002	F33	F133	MCM #5 - 066	G5
F98	MCM #5 - 005	F34	F134	MCM #5 - 067	G6
F99	MCM #5 - 006	F35	F135	MCM #5 - 068	G7
F100	MCM #5 - 007	F36	F136	MCM #5 - 071	G8
F101	MCM #5 - 010	F37	F137	MCM #5 - 072	G9
F102	MCM #5 - 011	F38	F138	MCM #5 - 073	G10
F103	MCM #5 - 012	F39	F139	MCM #5 - 074	G11
F104	MCM #5 - 013	F40	F140	MCM #5 - 077	G12
F105	MCM #5 - 016	F41	F141	MCM #5 - 078	G13
F106	MCM #5 - 017	F42	F142	MCM #5 - 081	G14
F107	MCM #5 - 020	F43	F143	MCM #5 - 082	G15
F108	MCM #5 - 021	F44	F144	MCM #5 - 083	G16
F109	MCM #5 - 022	F45	G81	MCM #5 - 084	G17
F110	MCM #5 - 023	F46	G82	MCM #5 - 087	G18
F111	MCM #5 - 026	F47	G83	MCM #5 - 088	G19
F112	MCM #5 - 027	F48	G84	MCM #5 - 091	G20
F113	MCM #5 - 028	F49	G85	MCM #5 - 092	G21
F114	MCM #5 - 029	F50	G86	MCM #5 - 094	G22
F115	MCM #5 - 032	F51	G87	MCM #5 - 097	G23
F116	MCM #5 - 036	F52	G88	MCM #5 - 098	G24
F117	MCM #5 - 037	F53	G89	MCM #5 - 099	G25
F118	MCM #5 - 038	F54	G90	MCM #5 - 102	G26
F119	MCM #5 - 041	F55	G91	MCM #5 - 103	G27
F120	MCM #5 - 042	F56	G92	MCM #5 - 104	G28
F121	MCM #5 - 043	F57	G93	MCM #5 - 107	G29
F122	MCM #5 - 046	F58	G94	MCM #5 - 108	G30
F123	MCM #5 - 047	F59	G95	MCM #5 - 109	G31
F124	MCM #5 - 048	F60	G96	MCM #5 - 110	G32
F125	MCM #5 - 049	F61	G97	MCM #5 - 113	G33
F126	MCM #5 - 052	F62	G98	MCM #5 - 114	G34
F127	MCM #5 - 053	F63	G99	MCM #5 - 117	G35
F128	MCM #5 - 056	F64	G100	MCM #5 - 118	G36
F129	MCM #5 - 057	G1	G101	MCM #5 - 119	G37
F130	MCM #5 - 058	G2	G102	MCM #5 - 120	G38
F131	MCM #5 - 059	G3	G103	MCM #5 - 123	G39
F132	MCM #5 - 062	G4	G104	MCM #5 - 124	G40

**Table 6**

Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion	Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion
G105	MCM #6 - 002	G41	G141	MCM #6 - 066	G77
G106	MCM #6 - 005	G42	G142	MCM #6 - 067	G78
G107	MCM #6 - 006	G43	G143	MCM #6 - 068	G79
G108	MCM #6 - 007	G44	G144	MCM #6 - 071	G80
G109	MCM #6 - 010	G45	G145	MCM #6 - 072	H1
G110	MCM #6 - 011	G46	G146	MCM #6 - 073	H2
G111	MCM #6 - 012	G47	G147	MCM #6 - 074	H3
G112	MCM #6 - 013	G48	G148	MCM #6 - 077	H4
G113	MCM #6 - 016	G49	G149	MCM #6 - 078	H5
G114	MCM #6 - 017	G50	G150	MCM #6 - 081	H6
G115	MCM #6 - 020	G51	G151	MCM #6 - 082	H7
G116	MCM #6 - 021	G52	G152	MCM #6 - 083	H8
G117	MCM #6 - 022	G53	G153	MCM #6 - 084	H9
G118	MCM #6 - 023	G54	G154	MCM #6 - 087	H10
G119	MCM #6 - 026	G55	G155	MCM #6 - 088	H11
G120	MCM #6 - 027	G56	G156	MCM #6 - 091	H12
G121	MCM #6 - 028	G57	G157	MCM #6 - 092	H13
G122	MCM #6 - 029	G58	G158	MCM #6 - 094	H14
G123	MCM #6 - 032	G59	G159	MCM #6 - 097	H15
G124	MCM #6 - 036	G60	G160	MCM #6 - 098	H16
G125	MCM #6 - 037	G61	H97	MCM #6 - 099	H17
G126	MCM #6 - 038	G62	H98	MCM #6 - 102	H18
G127	MCM #6 - 041	G63	H99	MCM #6 - 103	H19
G128	MCM #6 - 042	G64	H100	MCM #6 - 104	H20
G129	MCM #6 - 043	G65	H101	MCM #6 - 107	H21
G130	MCM #6 - 046	G66	H102	MCM #6 - 108	H22
G131	MCM #6 - 047	G67	H103	MCM #6 - 109	H23
G132	MCM #6 - 048	G68	H104	MCM #6 - 110	H24
G133	MCM #6 - 049	G69	H105	MCM #6 - 113	H25
G134	MCM #6 - 052	G70	H106	MCM #6 - 114	H26
G135	MCM #6 - 053	G71	H107	MCM #6 - 117	H27
G136	MCM #6 - 056	G72	H108	MCM #6 - 118	H28
G137	MCM #6 - 057	G73	H109	MCM #6 - 119	H29
G138	MCM #6 - 058	G74	H110	MCM #6 - 120	H30
G139	MCM #6 - 059	G75	H111	MCM #6 - 123	H31
G140	MCM #6 - 062	G76	H112	MCM #6 - 124	H32

Table 7

Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion	Fiber seen by LH insertion	SVX channel number	Fiber seen by RH insertion
H113	MCM #7 - 010	H33	H145	MCM #7 - 066	H65
H114	MCM #7 - 011	H34	H146	MCM #7 - 067	H66
H115	MCM #7 - 012	H35	H147	MCM #7 - 068	H67
H116	MCM #7 - 013	H36	H148	MCM #7 - 071	H68
H117	MCM #7 - 016	H37	H149	MCM #7 - 072	H69
H118	MCM #7 - 017	H38	H150	MCM #7 - 073	H70
H119	MCM #7 - 020	H39	H151	MCM #7 - 074	H71
H120	MCM #7 - 021	H40	H152	MCM #7 - 077	H72
H121	MCM #7 - 022	H41	H153	MCM #7 - 078	H73
H122	MCM #7 - 023	H42	H154	MCM #7 - 081	H74
H123	MCM #7 - 026	H43	H155	MCM #7 - 082	H75
H124	MCM #7 - 027	H44	H156	MCM #7 - 083	H76
H125	MCM #7 - 028	H45	H157	MCM #7 - 084	H77
H126	MCM #7 - 029	H46	H158	MCM #7 - 087	H78
H127	MCM #7 - 032	H47	H159	MCM #7 - 088	H79
H128	MCM #7 - 036	H48	H160	MCM #7 - 091	H80
H129	MCM #7 - 037	H49	H161	MCM #7 - 092	H81
H130	MCM #7 - 038	H50	H162	MCM #7 - 094	H82
H131	MCM #7 - 041	H51	H163	MCM #7 - 097	H83
H132	MCM #7 - 042	H52	H164	MCM #7 - 098	H84
H133	MCM #7 - 043	H53	H165	MCM #7 - 099	H85
H134	MCM #7 - 046	H54	H166	MCM #7 - 102	H86
H135	MCM #7 - 047	H55	H167	MCM #7 - 103	H87
H136	MCM #7 - 048	H56	H168	MCM #7 - 104	H88
H137	MCM #7 - 049	H57	H169	MCM #7 - 107	H89
H138	MCM #7 - 052	H58	H170	MCM #7 - 108	H90
H139	MCM #7 - 053	H59	H171	MCM #7 - 109	H91
H140	MCM #7 - 056	H60	H172	MCM #7 - 110	H92
H141	MCM #7 - 057	H61	H173	MCM #7 - 113	H93
H142	MCM #7 - 058	H62	H174	MCM #7 - 114	H94
H143	MCM #7 - 059	H63	H175	MCM #7 - 117	H95
H144	MCM #7 - 062	H64	H176	MCM #7 - 118	H96

**Table 8**

For MCM #8, the Preshower information is duplicated, first for the high threshold of the charge split, and then for the low threshold valued. The high threshold data comes out first.

Fiber seen by LH insertion	SVX channel number (high threshold)	Fiber seen by RH insertion	Fiber seen by LH insertion	SVX channel number (low threshold)	Fiber seen by RH insertion
PSN17	MCM #8 - 010	PSN1	PSN17	MCM #8 - 066	PSN1
PSN18	MCM #8 - 011	PSN2	PSN18	MCM #8 - 067	PSN2
PSN19	MCM #8 - 012	PSN3	PSN19	MCM #8 - 068	PSN3
PSN20	MCM #8 - 013	PSN4	PSN20	MCM #8 - 071	PSN4
PSN21	MCM #8 - 016	PSN5	PSN21	MCM #8 - 072	PSN5
PSN22	MCM #8 - 017	PSN6	PSN22	MCM #8 - 073	PSN6
PSN23	MCM #8 - 020	PSN7	PSN23	MCM #8 - 074	PSN7
PSN24	MCM #8 - 021	PSN8	PSN24	MCM #8 - 077	PSN8
PSN25	MCM #8 - 022	PSN9	PSN25	MCM #8 - 078	PSN9
PSN26	MCM #8 - 023	PSN10	PSN26	MCM #8 - 081	PSN10
PSN27	MCM #8 - 026	PSN11	PSN27	MCM #8 - 082	PSN11
PSN28	MCM #8 - 027	PSN12	PSN28	MCM #8 - 083	PSN12
PSN29	MCM #8 - 028	PSN13	PSN29	MCM #8 - 084	PSN13
PSN30	MCM #8 - 029	PSN14	PSN30	MCM #8 - 087	PSN14
PSN31	MCM #8 - 032	PSN15	PSN31	MCM #8 - 088	PSN15
PSN32	MCM #8 - 036	PSN16	PSN32	MCM #8 - 091	PSN16
PSS17	MCM #8 - 037	PSS1	PSS17	MCM #8 - 092	PSS1
PSS18	MCM #8 - 038	PSS2	PSS18	MCM #8 - 094	PSS2
PSS19	MCM #8 - 041	PSS3	PSS19	MCM #8 - 097	PSS3
PSS20	MCM #8 - 042	PSS4	PSS20	MCM #8 - 098	PSS4
PSS21	MCM #8 - 043	PSS5	PSS21	MCM #8 - 099	PSS5
PSS22	MCM #8 - 046	PSS6	PSS22	MCM #8 - 102	PSS6
PSS23	MCM #8 - 047	PSS7	PSS23	MCM #8 - 103	PSS7
PSS24	MCM #8 - 048	PSS8	PSS24	MCM #8 - 104	PSS8
PSS25	MCM #8 - 049	PSS9	PSS25	MCM #8 - 107	PSS9
PSS26	MCM #8 - 052	PSS10	PSS26	MCM #8 - 108	PSS10
PSS27	MCM #8 - 053	PSS11	PSS27	MCM #8 - 109	PSS11
PSS28	MCM #8 - 056	PSS12	PSS28	MCM #8 - 110	PSS12
PSS29	MCM #8 - 057	PSS13	PSS29	MCM #8 - 113	PSS13
PSS30	MCM #8 - 058	PSS14	PSS30	MCM #8 - 114	PSS14
PSS31	MCM #8 - 059	PSS15	PSS31	MCM #8 - 117	PSS15
PSS32	MCM #8 - 062	PSS16	PSS32	MCM #8 - 118	PSS16

Table 9

## 9. Mapping of Fibers into the Digital Front End Boards

With the fibers now run into the Analog Front End boards and the SVX readout to Level 2 established, the details of transferring the fiber data from the Analog Front End boards to the Digital Front End boards need be discussed. Jamieson Olsen has an Engineering Note #990105a which gives an overview of this link. The document is found at <http://d0server1.fnal.gov/users/jamieson/www/notes/990105a.pdf>. To summarize the document, each of the Analog Front End boards generates 544 bits of discriminator output every event. One pair of Analog Front End boards drives a single Digital Front End board. That Digital Front End board also receives data from the Analog Front End boards associated with the sectors adjacent on each side.

The data is sent via high-speed LVDS copper links. To obtain the necessary bandwidth, three links are required to send all the bits from a single Analog Front End to the Digital Front End. In addition, one of the three links is duplicated at each Analog Front End, to send the 'edge' fibers to the Digital Front End of the adjacent sector pair. Thus, each Analog Front End board has four output links, and each Digital Front End board has eight input links.

Jamieson has employed a color coding scheme to indicate which fibers show up on which links. Figure 1 on page 4 shows the color scheme, which is summarized here:

- An Analog Front End board inserted in the 'left-hand' orientation drives the Red, Blue and Yellow links to its Digital Front End board. A second copy of the Red link is driven to the Digital Front End board of the adjacent sector pair.
- An Analog Front End board inserted in the 'right-hand' orientation drives the Purple, Orange and Green links to its Digital Front End board. A second copy of the Green link is driven to the Digital Front End board of the adjacent sector pair.

Every fiber's charge signal which lands on the Front End board is connected to a discriminator circuit in the MCM, which creates a digital output for that fiber. Silmilar to the information presented in Tables 2 through 9, Tables 10 through 19 show the relationship between:

- a given fiber number,
- the Cin:apse pin number upon which the data for that fiber is delivered to the Front End Analog board,
- which MCM pin has the corresponding discriminator output(s) for that Cin:Apse pin,
- which color link that pin is driven onto.

To interpret the tables, the Cin:Apse connectors are numbered 1 through 8 as done earlier in this document. The fiber number for both 'left-handed' and 'right-handed' insertions is compared to the Cin:apse pin number. The fixed mapping between a Cin:Apse pin number and a particular MCM's input and output pins is also given. To associate the data with Figure 1, the fiber number cell is colored using the same color code as in Figure 1. The LVDS link is also numbered, using the standard resistor color code convention (red = 2, orange = 3, yellow = 4, green = 5, blue = 6, purple = 7); this number is rather arbitrary but is helpful with Excel to sort which fibers go with which links. The MCM input and output pins are useful for probing on the Analog Front End board; the MCMs are numbered as given in Figure 7.

The LVDS links from the Front End Analog boards each utilize a circuit which sends 28 bits of data with every tick of the 53MHz clock. During a beam crossing interval (7 clock ticks), a maximum of 196 bits of data can be transmitted. Assuming 7 of these bits are reserved for synchronization information, 189 bits of discriminator output per crossing may be sent. Which bits are sent with each clock tick is relatively arbitrary as the link between the Analog and Digital boards is private, but for completeness Tables 20 through 25 give the blow-by-blow detail.

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
8--128	80	B64	2	5	B32	1--64	1-21	1-51
8--127	79	B63	2	5	B31	1--63	1-20	1-52
8--126	81	B62	2	5	B30	1--62	1-18	1-53
8--125	82	B61	2	5	B29	1--61	1-17	1-54
8--124	74	B60	2	5	B28	1--60	1-16	1-55
8--123	75	B59	2	5	B27	1--59	1-15	1-56
8--122	77	B58	2	5	B26	1--58	1-14	1-57
8--121	76	B57	2	5	B25	1--57	1-13	1-58
8--120	71	B56	2	5	B24	1--56	1-11	1-59
8--119	70	B55	2	5	B23	1--55	1-10	1-60
8--118	72	B54	2	5	B22	1--54	1-9	1-61
8--117	73	B53	2	5	B21	1--53	1-8	1-62
8--116	65	B52	2	5	B20	1--52	1-7	1-63
8--115	66	B51	2	5	B19	1--51	1-6	1-64
8--114	68	B50	2	5	B18	1--50	1-4	1-28
8--113	67	B49	2	5	B17	1--49	1-3	1-29
8--112	62	B48	4	5	B16	1--48	1-2	1-30
8--111	61	B47	4	5	B15	1--47	1-1	1-31
8--110	63	B46	4	5	B14	1--46	1-228	1-32
8--109	64	B45	4	5	B13	1--45	1-227	1-33
8--108	56	B44	4	5	B12	1--44	1-225	1-34
8--107	57	B43	4	5	B11	1--43	1-224	1-35
8--106	59	B42	4	5	B10	1--42	1-223	1-36
8--105	58	B41	4	5	B9	1--41	1-222	1-37
8--104	53	B40	4	5	B8	1--40	1-221	1-38
8--103	52	B39	4	5	B7	1--39	1-220	1-39
8--102	54	B38	4	5	B6	1--38	1-218	1-40
8--101	55	B37	4	5	B5	1--37	1-217	1-41
8--100	47	B36	4	5	B4	1--36	1-216	1-42
8--99	48	B35	4	5	B3	1--35	1-215	1-43
8--98	50	B34	4	5	B2	1--34	1-214	1-44
8--97	49	B33	4	5	B1	1--33	1-213	1-45
8--96	43	A64	2	7	A32	1--32	1-211	1-168
8--95	44	A63	2	7	A31	1--31	1-210	1-167
8--94	45	A62	2	7	A30	1--30	1-209	1-166
8--93	46	A61	2	7	A29	1--29	1-208	1-165

8--92	37	A60	2	5	A28	1--28	1-207	1-164
8--91	40	A59	2	5	A27	1--27	1-206	1-163
8--90	42	A58	2	5	A26	1--26	1-204	1-162
8--89	39	A57	2	5	A25	1--25	1-203	1-161
8--88	36	A56	2	5	A24	1--24	1-202	1-160
8--87	33	A55	2	5	A23	1--23	1-201	1-159
8--86	35	A54	2	5	A22	1--22	1-200	1-158
8--85	38	A53	2	5	A21	1--21	1-199	1-157
8--84	30	A52	2	5	A20	1--20	1-197	1-156
8--83	29	A51	2	5	A19	1--19	1-196	1-155
8--82	31	A50	2	5	A18	1--18	1-195	1-154
8--81	32	A49	2	5	A17	1--17	1-194	1-153
8--80	25	A48	2	5	A16	1--16	1-193	1-152
8--79	26	A47	2	5	A15	1--15	1-192	1-151
8--78	28	A46	2	5	A14	1--14	1-190	1-149
8--77	27	A45	2	5	A13	1--13	1-189	1-148
8--76	19	A44	2	5	A12	1--12	1-188	1-147
8--75	22	A43	2	5	A11	1--11	1-187	1-146
8--74	24	A42	2	5	A10	1--10	1-186	1-145
8--73	21	A41	2	5	A9	1--9	1-185	1-144
8--72	18	A40	2	5	A8	1--8	1-183	1-143
8--71	15	A39	2	5	A7	1--7	1-182	1-142
8--70	17	A38	2	5	A6	1--6	1-181	1-141
8--69	20	A37	2	5	A5	1--5	1-180	1-140
8--68	12	A36	4	5	A4	1--4	1-179	1-139
8--67	11	A35	4	5	A3	1--3	1-178	1-138
8--66	13	A34	4	5	A2	1--2	1-176	1-137
8--65	14	A33	4	5	A1	1--1	1-175	1-136

**Table 10 – Cin:Apse connector #8 (left-hand) / #1 (right-hand) pin to color link map**

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
7--128	80	C96	2	5	D16	2--64	2-21	2-51
7--127	79	C95	2	5	D15	2--63	2-20	2-52
7--126	81	C94	2	5	D14	2--62	2-18	2-53
7--125	82	C93	2	5	D13	2--61	2-17	2-54
7--124	74	C92	2	5	D12	2--60	2-16	2-55
7--123	75	C91	2	5	D11	2--59	2-15	2-56
7--122	77	C90	2	5	D10	2--58	2-14	2-57
7--121	76	C89	2	5	D9	2--57	2-13	2-58
7--120	71	C88	2	5	D8	2--56	2-11	2-59
7--119	70	C87	2	5	D7	2--55	2-10	2-60
7--118	72	C86	2	5	D6	2--54	2-9	2-61
7--117	73	C85	2	5	D5	2--53	2-8	2-62
7--116	65	C84	2	5	D4	2--52	2-7	2-63
7--115	66	C83	2	5	D3	2--51	2-6	2-64
7--114	68	C82	2	5	D2	2--50	2-4	2-28
7--113	67	C81	2	5	D1	2--49	2-3	2-29
7--112	62	C80	2	7	C48	2--48	2-2	2-30
7--111	61	C79	2	7	C47	2--47	2-1	2-31
7--110	63	C78	2	7	C46	2--46	2-228	2-32
7--109	64	C77	2	7	C45	2--45	2-227	2-33
7--108	56	C76	2	7	C44	2--44	2-225	2-34
7--107	57	C75	2	7	C43	2--43	2-224	2-35
7--106	59	C74	2	7	C42	2--42	2-223	2-36
7--105	58	C73	2	7	C41	2--41	2-222	2-37
7--104	53	C72	2	7	C40	2--40	2-221	2-38
7--103	52	C71	2	7	C39	2--39	2-220	2-39
7--102	54	C70	2	7	C38	2--38	2-218	2-40
7--101	55	C69	2	7	C37	2--37	2-217	2-41
7--100	47	C68	2	7	C36	2--36	2-216	2-42
7--99	48	C67	2	7	C35	2--35	2-215	2-43
7--98	50	C66	2	7	C34	2--34	2-214	2-44
7--97	49	C65	2	7	C33	2--33	2-213	2-45
7--96	43	C64	4	5	C32	2--32	2-211	2-168
7--95	44	C63	4	5	C31	2--31	2-210	2-167
7--94	45	C62	4	5	C30	2--30	2-209	2-166
7--93	46	C61	4	5	C29	2--29	2-208	2-165

7--92	37	C60	4	5	C28	2--28	2-207	2-164
7--91	40	C59	4	5	C27	2--27	2-206	2-163
7--90	42	C58	4	5	C26	2--26	2-204	2-162
7--89	39	C57	4	5	C25	2--25	2-203	2-161
7--88	36	C56	4	5	C24	2--24	2-202	2-160
7--87	33	C55	4	5	C23	2--23	2-201	2-159
7--86	35	C54	4	5	C22	2--22	2-200	2-158
7--85	38	C53	4	5	C21	2--21	2-199	2-157
7--84	30	C52	4	5	C20	2--20	2-197	2-156
7--83	29	C51	4	5	C19	2--19	2-196	2-155
7--82	31	C50	4	5	C18	2--18	2-195	2-154
7--81	32	C49	4	5	C17	2--17	2-194	2-153
7--80	25	B80	2	5	C16	2--16	2-193	2-152
7--79	26	B79	2	5	C15	2--15	2-192	2-151
7--78	28	B78	2	5	C14	2--14	2-190	2-149
7--77	27	B77	2	5	C13	2--13	2-189	2-148
7--76	19	B76	2	5	C12	2--12	2-188	2-147
7--75	22	B75	2	5	C11	2--11	2-187	2-146
7--74	24	B74	2	5	C10	2--10	2-186	2-145
7--73	21	B73	2	5	C9	2--9	2-185	2-144
7--72	18	B72	2	5	C8	2--8	2-183	2-143
7--71	15	B71	2	5	C7	2--7	2-182	2-142
7--70	17	B70	2	5	C6	2--6	2-181	2-141
7--69	20	B69	2	5	C5	2--5	2-180	2-140
7--68	12	B68	2	5	C4	2--4	2-179	2-139
7--67	11	B67	2	5	C3	2--3	2-178	2-138
7--66	13	B66	2	5	C2	2--2	2-176	2-137
7--65	14	B65	2	5	C1	2--1	2-175	2-136

**Table 11– Cin:Apse connector #7 (left-hand) / #2 (right-hand) pin to color link map**

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
6--128	80	E80	4	5	E16	3--64	3-16	3-55
6--127	79	E79	4	5	E15	3--63	3-15	3-56
6--126	81	E78	4	5	E14	3--62	3-14	3-57
6--125	82	E77	4	5	E13	3--61	3-13	3-58
6--124	74	E76	4	5	E12	3--60	3-11	3-59
6--123	75	E75	4	5	E11	3--59	3-10	3-60
6--122	77	E74	4	5	E10	3--58	3-9	3-61
6--121	76	E73	4	5	E9	3--57	3-8	3-62
6--120	71	E72	4	5	E8	3--56	3-7	3-63
6--119	70	E71	4	5	E7	3--55	3-6	3-64
6--118	72	E70	4	5	E6	3--54	3-4	3-28
6--117	73	E69	4	5	E5	3--53	3-3	3-29
6--116	65	E68	4	5	E4	3--52	3-2	3-30
6--115	66	E67	4	5	E3	3--51	3-1	3-31
6--114	68	E66	4	5	E2	3--50	3-228	3-32
6--113	67	E65	4	5	E1	3--49	3-227	3-33
6--112	62	D112	2	7	D64	3--48	3-225	3-34
6--111	61	D111	2	7	D63	3--47	3-224	3-35
6--110	63	D110	2	7	D62	3--46	3-223	3-36
6--109	64	D109	2	7	D61	3--45	3-222	3-37
6--108	56	D108	2	7	D60	3--44	3-221	3-38
6--107	57	D107	2	7	D59	3--43	3-220	3-39
6--106	59	D106	2	7	D58	3--42	3-218	3-40
6--105	58	D105	2	7	D57	3--41	3-217	3-41
6--104	53	D104	2	7	D56	3--40	3-216	3-42
6--103	52	D103	2	7	D55	3--39	3-215	3-43
6--102	54	D102	2	7	D54	3--38	3-214	3-44
6--101	55	D101	2	7	D53	3--37	3-213	3-45
6--100	47	D100	2	7	D52	3--36	3-211	3-168
6--99	48	D99	2	7	D51	3--35	3-210	3-167
6--98	50	D98	2	7	D50	3--34	3-209	3-166
6--97	49	D97	2	7	D49	3--33	3-208	3-165
6--96	43	D96	2	7	D48	3--32	3-207	3-164
6--95	44	D95	2	7	D47	3--31	3-206	3-163
6--94	45	D94	2	7	D46	3--30	3-204	3-162
6--93	46	D93	2	7	D45	3--29	3-203	3-161

6--92	37	D92	2	7	D44	3--28	3-202	3-160
6--91	40	D91	2	7	D43	3--27	3-201	3-159
6--90	42	D90	2	7	D42	3--26	3-200	3-158
6--89	39	D89	2	7	D41	3--25	3-199	3-157
6--88	36	D88	2	7	D40	3--24	3-197	3-156
6--87	33	D87	2	7	D39	3--23	3-196	3-155
6--86	35	D86	2	7	D38	3--22	3-195	3-154
6--85	38	D85	2	7	D37	3--21	3-194	3-153
6--84	30	D84	2	7	D36	3--20	3-193	3-152
6--83	29	D83	2	7	D35	3--19	3-192	3-151
6--82	31	D82	4	7	D34	3--18	3-190	3-149
6--81	32	D81	4	7	D33	3--17	3-189	3-148
6--80	25	D80	4	7	D32	3--16	3-188	3-147
6--79	26	D79	4	7	D31	3--15	3-187	3-146
6--78	28	D78	4	5	D30	3--14	3-186	3-145
6--77	27	D77	4	5	D29	3--13	3-185	3-144
6--76	19	D76	4	5	D28	3--12	3-183	3-143
6--75	22	D75	4	5	D27	3--11	3-182	3-142
6--74	24	D74	4	5	D26	3--10	3-181	3-141
6--73	21	D73	4	5	D25	3--9	3-180	3-140
6--72	18	D72	4	5	D24	3--8	3-179	3-139
6--71	15	D71	4	5	D23	3--7	3-178	3-138
6--70	17	D70	4	5	D22	3--6	3-176	3-137
6--69	20	D69	4	5	D21	3--5	3-175	3-136
6--68	12	D68	4	5	D20	3--4	3-174	3-135
6--67	11	D67	4	5	D19	3--3	3-173	3-134
6--66	13	D66	4	5	D18	3--2	3-172	3-133
6--65	14	D65	4	5	D17	3--1	3-171	3-132

**Table 12– Cin:Apse connector #6 (left-hand) / #3 (right-hand) pin to color link map**

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
5--128	80	F80	4	5	F16	4--64	4-7	4-63
5--127	79	F79	4	5	F15	4--63	4-6	4-64
5--126	81	F78	4	5	F14	4--62	4-4	4-28
5--125	82	F77	4	5	F13	4--61	4-3	4-29
5--124	74	F76	4	5	F12	4--60	4-2	4-30
5--123	75	F75	4	5	F11	4--59	4-1	4-31
5--122	77	F74	4	5	F10	4--58	4-228	4-32
5--121	76	F73	4	5	F9	4--57	4-227	4-33
5--120	71	F72	4	5	F8	4--56	4-225	4-34
5--119	70	F71	4	5	F7	4--55	4-224	4-35
5--118	72	F70	4	5	F6	4--54	4-223	4-36
5--117	73	F69	4	5	F5	4--53	4-222	4-37
5--116	65	F68	4	5	F4	4--52	4-221	4-38
5--115	66	F67	4	5	F3	4--51	4-220	4-39
5--114	68	F66	4	5	F2	4--50	4-218	4-40
5--113	67	F65	4	5	F1	4--49	4-217	4-41
5--112	62	E128	2	7	E64	4--48	4-216	4-42
5--111	61	E127	2	7	E63	4--47	4-215	4-43
5--110	63	E126	2	7	E62	4--46	4-214	4-44
5--109	64	E125	2	7	E61	4--45	4-213	4-45
5--108	56	E124	2	7	E60	4--44	4-211	4-168
5--107	57	E123	2	7	E59	4--43	4-210	4-167
5--106	59	E122	2	7	E58	4--42	4-209	4-166
5--105	58	E121	2	7	E57	4--41	4-208	4-165
5--104	53	E120	2	7	E56	4--40	4-207	4-164
5--103	52	E119	2	7	E55	4--39	4-206	4-163
5--102	54	E118	2	7	E54	4--38	4-204	4-162
5--101	55	E117	2	7	E53	4--37	4-203	4-161
5--100	47	E116	2	7	E52	4--36	4-202	4-160
5--99	48	E115	2	7	E51	4--35	4-201	4-159
5--98	50	E114	2	7	E50	4--34	4-200	4-158
5--97	49	E113	2	7	E49	4--33	4-199	4-157
5--96	43	E112	2	7	E48	4--32	4-197	4-156
5--95	44	E111	2	7	E47	4--31	4-196	4-155
5--94	45	E110	2	7	E46	4--30	4-195	4-154
5--93	46	E109	2	7	E45	4--29	4-194	4-153

5--92	37	E108	2	7	E44	4--28	4-193	4-152
5--91	40	E107	2	7	E43	4--27	4-192	4-151
5--90	42	E106	2	7	E42	4--26	4-190	4-149
5--89	39	E105	2	7	E41	4--25	4-189	4-148
5--88	36	E104	4	7	E40	4--24	4-188	4-147
5--87	33	E103	4	7	E39	4--23	4-187	4-146
5--86	35	E102	4	7	E38	4--22	4-186	4-145
5--85	38	E101	4	7	E37	4--21	4-185	4-144
5--84	30	E100	4	7	E36	4--20	4-183	4-143
5--83	29	E99	4	7	E35	4--19	4-182	4-142
5--82	31	E98	4	7	E34	4--18	4-181	4-141
5--81	32	E97	4	7	E33	4--17	4-180	4-140
5--80	25	E96	4	7	E32	4--16	4-179	4-139
5--79	26	E95	4	7	E31	4--15	4-178	4-138
5--78	28	E94	4	7	E30	4--14	4-176	4-137
5--77	27	E93	4	7	E29	4--13	4-175	4-136
5--76	19	E92	4	7	E28	4--12	4-174	4-135
5--75	22	E91	4	7	E27	4--11	4-173	4-134
5--74	24	E90	4	7	E26	4--10	4-172	4-133
5--73	21	E89	4	7	E25	4--9	4-171	4-132
5--72	18	E88	4	5	E24	4--8	3-25	3-47
5--71	15	E87	4	5	E23	4--7	3-24	3-48
5--70	17	E86	4	5	E22	4--6	3-23	3-49
5--69	20	E85	4	5	E21	4--5	3-22	3-50
5--68	12	E84	4	5	E20	4--4	3-21	3-51
5--67	11	E83	4	5	E19	4--3	3-20	3-52
5--66	13	E82	4	5	E18	4--2	3-18	3-53
5--65	14	E81	4	5	E17	4--1	3-17	3-54

**Table 13– Cin:Apse connector #5 (left-hand) / #4 (right-hand) pin to color link map**

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
4--128	80	F112	6	7	F48	5--64	5-188	5-147
4--127	79	F111	6	7	F47	5--63	5-187	5-146
4--126	81	F110	6	7	F46	5--62	5-186	5-145
4--125	82	F109	6	7	F45	5--61	5-185	5-144
4--124	74	F108	6	7	F44	5--60	5-183	5-143
4--123	75	F107	6	7	F43	5--59	5-182	5-142
4--122	77	F106	4	7	F42	5--58	5-181	5-141
4--121	76	F105	4	7	F41	5--57	5-180	5-140
4--120	71	F104	4	7	F40	5--56	5-179	5-139
4--119	70	F103	4	7	F39	5--55	5-178	5-138
4--118	72	F102	4	3	F38	5--54	5-176	5-137
4--117	73	F101	4	3	F37	5--53	5-175	5-136
4--116	65	F100	4	3	F36	5--52	5-174	5-135
4--115	66	F99	4	3	F35	5--51	5-173	5-134
4--114	68	F98	4	3	F34	5--50	5-172	5-133
4--113	67	F97	4	3	F33	5--49	5-171	5-132
4--112	62	F96	4	3	F32	5--48	4-25	4-47
4--111	61	F95	4	3	F31	5--47	4-24	4-48
4--110	63	F94	4	3	F30	5--46	4-23	4-49
4--109	64	F93	4	3	F29	5--45	4-22	4-50
4--108	56	F92	4	3	F28	5--44	4-21	4-51
4--107	57	F91	4	3	F27	5--43	4-20	4-52
4--106	59	F90	4	3	F26	5--42	4-18	4-53
4--105	58	F89	4	3	F25	5--41	4-17	4-54
4--104	53	F88	4	3	F24	5--40	4-16	4-55
4--103	52	F87	4	3	F23	5--39	4-15	4-56
4--102	54	F86	4	3	F22	5--38	4-14	4-57
4--101	55	F85	4	3	F21	5--37	4-13	4-58
4--100	47	F84	4	3	F20	5--36	4-11	4-59
4--99	48	F83	4	3	F19	5--35	4-10	4-60
4--98	50	F82	4	5	F18	5--34	4-9	4-61
4--97	49	F81	4	5	F17	5--33	4-8	4-62

Table 14– Cin:Apse connector #4 (left-hand) / #5 (right-hand) pin to color link map

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
4--96	43	PSS32	2	7	PSS16	5--32	8-21	8-51
4--95	44	PSS31	2	7	PSS15	5--31	8-20	8-52
4--94	45	PSS30	2	7	PSS14	5--30	8-18	8-53
4--93	46	PSS29	2	7	PSS13	5--29	8-17	8-54
4--92	37	PSS28	6	3	PSS12	5--28	8-16	8-55
4--91	40	PSS27	6	3	PSS11	5--27	8-15	8-56
4--90	42	PSS26	6	3	PSS10	5--26	8-14	8-57
4--89	39	PSS25	6	3	PSS9	5--25	8-13	8-58
4--88	36	PSS24	6	3	PSS8	5--24	8-11	8-59
4--87	33	PSS23	6	3	PSS7	5--23	8-10	8-60
4--86	35	PSS22	6	3	PSS6	5--22	8-9	8-61
4--85	38	PSS21	6	3	PSS5	5--21	8-8	8-62
4--84	30	PSS20	4	5	PSS4	5--20	8-7	8-63
4--83	29	PSS19	4	5	PSS3	5--19	8-6	8-64
4--82	31	PSS18	4	5	PSS2	5--18	8-4	8-28
4--81	32	PSS17	4	5	PSS1	5--17	8-3	8-29
4--80	25	PSN32	2	7	PSN16	5--16	8-2	8-30
4--79	26	PSN31	2	7	PSN15	5--15	8-1	8-31
4--78	28	PSN30	2	7	PSN14	5--14	8-228	8-32
4--77	27	PSN29	2	7	PSN13	5--13	8-227	8-33
4--76	19	PSN28	6	3	PSN12	5--12	8-225	8-34
4--75	22	PSN27	6	3	PSN11	5--11	8-224	8-35
4--74	24	PSN26	6	3	PSN10	5--10	8-223	8-36
4--73	21	PSN25	6	3	PSN9	5--9	8-222	8-37
4--72	18	PSN24	6	3	PSN8	5--8	8-221	8-38
4--71	15	PSN23	6	3	PSN7	5--7	8-220	8-39
4--70	17	PSN22	6	3	PSN6	5--6	8-218	8-40
4--69	20	PSN21	6	3	PSN5	5--5	8-217	8-41
4--68	12	PSN20	4	5	PSN4	5--4	8-216	8-42
4--67	11	PSN19	4	5	PSN3	5--3	8-215	8-43
4--66	13	PSN18	4	5	PSN2	5--2	8-214	8-44
4--65	14	PSN17	4	5	PSN1	5--1	8-213	8-45

**Table 15 – Preshower (Low threshold) pin map**

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
4--96	43	PSS32	2	7	PSS16	5--32	8-211	8-168
4--95	44	PSS31	2	7	PSS15	5--31	8-210	8-167
4--94	45	PSS30	2	7	PSS14	5--30	8-209	8-166
4--93	46	PSS29	2	7	PSS13	5--29	8-208	8-165
4--92	37	PSS28	6	3	PSS12	5--28	8-207	8-164
4--91	40	PSS27	6	3	PSS11	5--27	8-206	8-163
4--90	42	PSS26	6	3	PSS10	5--26	8-204	8-162
4--89	39	PSS25	6	3	PSS9	5--25	8-203	8-161
4--88	36	PSS24	6	3	PSS8	5--24	8-202	8-160
4--87	33	PSS23	6	3	PSS7	5--23	8-201	8-159
4--86	35	PSS22	6	3	PSS6	5--22	8-200	8-158
4--85	38	PSS21	6	3	PSS5	5--21	8-199	8-157
4--84	30	PSS20	4	5	PSS4	5--20	8-197	8-156
4--83	29	PSS19	4	5	PSS3	5--19	8-196	8-155
4--82	31	PSS18	4	5	PSS2	5--18	8-195	8-154
4--81	32	PSS17	4	5	PSS1	5--17	8-194	8-153
4--80	25	PSN32	2	7	PSN16	5--16	8-193	8-152
4--79	26	PSN31	2	7	PSN15	5--15	8-192	8-151
4--78	28	PSN30	2	7	PSN14	5--14	8-190	8-149
4--77	27	PSN29	2	7	PSN13	5--13	8-189	8-148
4--76	19	PSN28	6	3	PSN12	5--12	8-188	8-147
4--75	22	PSN27	6	3	PSN11	5--11	8-187	8-146
4--74	24	PSN26	6	3	PSN10	5--10	8-186	8-145
4--73	21	PSN25	6	3	PSN9	5--9	8-185	8-144
4--72	18	PSN24	6	3	PSN8	5--8	8-183	8-143
4--71	15	PSN23	6	3	PSN7	5--7	8-182	8-142
4--70	17	PSN22	6	3	PSN6	5--6	8-181	8-141
4--69	20	PSN21	6	3	PSN5	5--5	8-180	8-140
4--68	12	PSN20	4	5	PSN4	5--4	8-179	8-139
4--67	11	PSN19	4	5	PSN3	5--3	8-178	8-138
4--66	13	PSN18	4	5	PSN2	5--2	8-176	8-137
4--65	14	PSN17	4	5	PSN1	5--1	8-175	8-136

Table 16– Preshower (High threshold) pin map

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
3--128	80	G112	6	3	G48	6--64	6-179	6-139
3--127	79	G111	6	3	G47	6--63	6-178	6-138
3--126	81	G110	6	3	G46	6--62	6-176	6-137
3--125	82	G109	6	3	G45	6--61	6-175	6-136
3--124	74	G108	4	3	G44	6--60	6-174	6-135
3--123	75	G107	4	3	G43	6--59	6-173	6-134
3--122	77	G106	4	3	G42	6--58	6-172	6-133
3--121	76	G105	4	3	G41	6--57	6-171	6-132
3--120	71	G104	4	3	G40	6--56	5-25	5-47
3--119	70	G103	4	3	G39	6--55	5-24	5-48
3--118	72	G102	4	3	G38	6--54	5-23	5-49
3--117	73	G101	4	3	G37	6--53	5-22	5-50
3--116	65	G100	4	3	G36	6--52	5-21	5-51
3--115	66	G99	4	3	G35	6--51	5-20	5-52
3--114	68	G98	4	3	G34	6--50	5-18	5-53
3--113	67	G97	4	3	G33	6--49	5-17	5-54
3--112	62	G96	4	3	G32	6--48	5-16	5-55
3--111	61	G95	4	3	G31	6--47	5-15	5-56
3--110	63	G94	4	3	G30	6--46	5-14	5-57
3--109	64	G93	4	3	G29	6--45	5-13	5-58
3--108	56	G92	4	3	G28	6--44	5-11	5-59
3--107	57	G91	4	3	G27	6--43	5-10	5-60
3--106	59	G90	4	3	G26	6--42	5-9	5-61
3--105	58	G89	4	3	G25	6--41	5-8	5-62
3--104	53	G88	4	3	G24	6--40	5-7	5-63
3--103	52	G87	4	3	G23	6--39	5-6	5-64
3--102	54	G86	4	3	G22	6--38	5-4	5-28
3--101	55	G85	4	3	G21	6--37	5-3	5-29
3--100	47	G84	4	3	G20	6--36	5-2	5-30
3--99	48	G83	4	3	G19	6--35	5-1	5-31
3--98	50	G82	4	3	G18	6--34	5-228	5-32
3--97	49	G81	4	3	G17	6--33	5-227	5-33
3--96	43	F144	2	3	G16	6--32	5-225	5-34
3--95	44	F143	2	3	G15	6--31	5-224	5-35
3--94	45	F142	2	3	G14	6--30	5-223	5-36
3--93	46	F141	2	3	G13	6--29	5-222	5-37

3--92	37	F140	2	3	G12	6--28	5-221	5-38
3--91	40	F139	2	3	G11	6--27	5-220	5-39
3--90	42	F138	2	3	G10	6--26	5-218	5-40
3--89	39	F137	2	3	G9	6--25	5-217	5-41
3--88	36	F136	2	3	G8	6--24	5-216	5-42
3--87	33	F135	2	3	G7	6--23	5-215	5-43
3--86	35	F134	2	5	G6	6--22	5-214	5-44
3--85	38	F133	2	5	G5	6--21	5-213	5-45
3--84	30	F132	2	5	G4	6--20	5-211	5-168
3--83	29	F131	2	5	G3	6--19	5-210	5-167
3--82	31	F130	2	5	G2	6--18	5-209	5-166
3--81	32	F129	2	5	G1	6--17	5-208	5-165
3--80	25	F128	2	7	F64	6--16	5-207	5-164
3--79	26	F127	2	7	F63	6--15	5-206	5-163
3--78	28	F126	6	7	F62	6--14	5-204	5-162
3--77	27	F125	6	7	F61	6--13	5-203	5-161
3--76	19	F124	6	7	F60	6--12	5-202	5-160
3--75	22	F123	6	7	F59	6--11	5-201	5-159
3--74	24	F122	6	7	F58	6--10	5-200	5-158
3--73	21	F121	6	7	F57	6--9	5-199	5-157
3--72	18	F120	6	7	F56	6--8	5-197	5-156
3--71	15	F119	6	7	F55	6--7	5-196	5-155
3--70	17	F118	6	7	F54	6--6	5-195	5-154
3--69	20	F117	6	7	F53	6--5	5-194	5-153
3--68	12	F116	6	7	F52	6--4	5-193	5-152
3--67	11	F115	6	7	F51	6--3	5-192	5-151
3--66	13	F114	6	7	F50	6--2	5-190	5-149
3--65	14	F113	6	7	F49	6--1	5-189	5-148

**Table 17– Cin:Apse connector #3 (left-hand) / #6 (right-hand) pin to color link map**

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
2--128	80	H112	6	3	H32	7--64	F-25	F-47
2--127	79	H111	6	3	H31	7--63	F-24	F-48
2--126	81	H110	6	3	H30	7--62	F-23	F-49
2--125	82	H109	6	3	H29	7--61	F-22	F-50
2--124	74	H108	6	3	H28	7--60	F-21	F-51
2--123	75	H107	6	3	H27	7--59	F-20	F-52
2--122	77	H106	6	3	H26	7--58	F-18	F-53
2--121	76	H105	6	3	H25	7--57	F-17	F-54
2--120	71	H104	4	3	H24	7--56	F-16	F-55
2--119	70	H103	4	3	H23	7--55	F-15	F-56
2--118	72	H102	4	3	H22	7--54	F-14	F-57
2--117	73	H101	4	3	H21	7--53	F-13	F-58
2--116	65	H100	4	3	H20	7--52	F-11	F-59
2--115	66	H99	4	3	H19	7--51	F-10	F-60
2--114	68	H98	4	3	H18	7--50	F-9	F-61
2--113	67	H97	4	3	H17	7--49	F-8	F-62
2--112	62	G160	2	3	H16	7--48	F-7	F-63
2--111	61	G159	2	3	H15	7--47	F-6	F-64
2--110	63	G158	2	3	H14	7--46	F-4	F-28
2--109	64	G157	2	3	H13	7--45	F-3	F-29
2--108	56	G156	2	3	H12	7--44	F-2	F-30
2--107	57	G155	2	3	H11	7--43	F-1	F-31
2--106	59	G154	6	3	H10	7--42	F-228	F-32
2--105	58	G153	6	3	H9	7--41	F-227	F-33
2--104	53	G152	6	3	H8	7--40	F-225	F-34
2--103	52	G151	6	3	H7	7--39	F-224	F-35
2--102	54	G150	6	3	H6	7--38	F-223	F-36
2--101	55	G149	6	3	H5	7--37	F-222	F-37
2--100	47	G148	6	3	H4	7--36	F-221	F-38
2--99	48	G147	6	3	H3	7--35	F-220	F-39
2--98	50	G146	6	5	H2	7--34	F-218	F-40
2--97	49	G145	6	5	H1	7--33	F-217	F-41
2--96	43	G144	6	7	G80	7--32	F-216	F-42
2--95	44	G143	6	7	G79	7--31	F-215	F-43
2--94	45	G142	6	7	G78	7--30	F-214	F-44
2--93	46	G141	6	7	G77	7--29	F-213	F-45

2--92	37	G140	6	7	G76	7--28	F-211	F-168
2--91	40	G139	6	7	G75	7--27	F-210	F-167
2--90	42	G138	6	7	G74	7--26	F-209	F-166
2--89	39	G137	6	7	G73	7--25	F-208	F-165
2--88	36	G136	6	7	G72	7--24	F-207	F-164
2--87	33	G135	6	7	G71	7--23	F-206	F-163
2--86	35	G134	6	7	G70	7--22	F-204	F-162
2--85	38	G133	6	7	G69	7--21	F-203	F-161
2--84	30	G132	6	7	G68	7--20	F-202	F-160
2--83	29	G131	6	7	G67	7--19	F-201	F-159
2--82	31	G130	6	7	G66	7--18	F-200	F-158
2--81	32	G129	6	7	G65	7--17	F-199	F-157
2--80	25	G128	6	7	G64	7--16	F-197	F-156
2--79	26	G127	6	7	G63	7--15	F-196	F-155
2--78	28	G126	6	7	G62	7--14	F-195	F-154
2--77	27	G125	6	7	G61	7--13	F-194	F-153
2--76	19	G124	6	7	G60	7--12	F-193	F-152
2--75	22	G123	6	7	G59	7--11	F-192	F-151
2--74	24	G122	6	7	G58	7--10	F-190	F-149
2--73	21	G121	6	7	G57	7--9	F-189	F-148
2--72	18	G120	6	7	G56	7--8	F-188	F-147
2--71	15	G119	6	7	G55	7--7	F-187	F-146
2--70	17	G118	6	7	G54	7--6	F-186	F-145
2--69	20	G117	6	7	G53	7--5	F-185	F-144
2--68	12	G116	6	3	G52	7--4	F-183	F-143
2--67	11	G115	6	3	G51	7--3	F-182	F-142
2--66	13	G114	6	3	G50	7--2	F-181	F-141
2--65	14	G113	6	3	G49	7--1	F-180	F-140

**Table 18– Cin:Apse connector #2 (left-hand) / #7 (right-hand) pin to color link map**

Optical connector position (LH insertion)	Cin:Apse pin on board	Fiber seen by LH insertion	LVDS Link (LHB)	LVDS Link (RHB)	Fiber seen by RH insertion	Optical connector position (RH insertion)	MCM pin driven	MCM Output Pin
1--128	80	H176	2	7	H96	8--64	G-21	G-51
1--127	79	H175	2	7	H95	8--63	G-20	G-52
1--126	81	H174	6	7	H94	8--62	G-18	G-53
1--125	82	H173	6	7	H93	8--61	G-17	G-54
1--124	74	H172	6	7	H92	8--60	G-16	G-55
1--123	75	H171	6	7	H91	8--59	G-15	G-56
1--122	77	H170	6	7	H90	8--58	G-14	G-57
1--121	76	H169	6	7	H89	8--57	G-13	G-58
1--120	71	H168	6	7	H88	8--56	G-11	G-59
1--119	70	H167	6	7	H87	8--55	G-10	G-60
1--118	72	H166	6	7	H86	8--54	G-9	G-61
1--117	73	H165	6	7	H85	8--53	G-8	G-62
1--116	65	H164	6	7	H84	8--52	G-7	G-63
1--115	66	H163	6	7	H83	8--51	G-6	G-64
1--114	68	H162	6	7	H82	8--50	G-4	G-28
1--113	67	H161	6	7	H81	8--49	G-3	G-29
1--112	62	H160	6	7	H80	8--48	G-2	G-30
1--111	61	H159	6	7	H79	8--47	G-1	G-31
1--110	63	H158	6	7	H78	8--46	G-228	G-32
1--109	64	H157	6	7	H77	8--45	G-227	G-33
1--108	56	H156	6	7	H76	8--44	G-225	G-34
1--107	57	H155	6	7	H75	8--43	G-224	G-35
1--106	59	H154	6	7	H74	8--42	G-223	G-36
1--105	58	H153	6	7	H73	8--41	G-222	G-37
1--104	53	H152	6	3	H72	8--40	G-221	G-38
1--103	52	H151	6	3	H71	8--39	G-220	G-39
1--102	54	H150	6	3	H70	8--38	G-218	G-40
1--101	55	H149	6	3	H69	8--37	G-217	G-41
1--100	47	H148	6	3	H68	8--36	G-216	G-42
1--99	48	H147	6	3	H67	8--35	G-215	G-43
1--98	50	H146	6	3	H66	8--34	G-214	G-44
1--97	49	H145	6	3	H65	8--33	G-213	G-45
1--96	43	H144	6	3	H64	8--32	G-211	G-168
1--95	44	H143	6	3	H63	8--31	G-210	G-167
1--94	45	H142	6	3	H62	8--30	G-209	G-166
1--93	46	H141	6	3	H61	8--29	G-208	G-165

1--92	37	H140	6	3	H60	8--28	G-207	G-164
1--91	40	H139	6	3	H59	8--27	G-206	G-163
1--90	42	H138	6	3	H58	8--26	G-204	G-162
1--89	39	H137	6	3	H57	8--25	G-203	G-161
1--88	36	H136	6	3	H56	8--24	G-202	G-160
1--87	33	H135	6	3	H55	8--23	G-201	G-159
1--86	35	H134	6	3	H54	8--22	G-200	G-158
1--85	38	H133	6	3	H53	8--21	G-199	G-157
1--84	30	H132	6	3	H52	8--20	G-197	G-156
1--83	29	H131	6	3	H51	8--19	G-196	G-155
1--82	31	H130	6	3	H50	8--18	G-195	G-154
1--81	32	H129	6	3	H49	8--17	G-194	G-153
1--80	25	H128	6	3	H48	8--16	G-193	G-152
1--79	26	H127	6	3	H47	8--15	G-192	G-151
1--78	28	H126	6	3	H46	8--14	G-190	G-149
1--77	27	H125	6	3	H45	8--13	G-189	G-148
1--76	19	H124	6	3	H44	8--12	G-188	G-147
1--75	22	H123	6	3	H43	8--11	G-187	G-146
1--74	24	H122	6	3	H42	8--10	G-186	G-145
1--73	21	H121	6	3	H41	8--9	G-185	G-144
1--72	18	H120	6	3	H40	8--8	G-183	G-143
1--71	15	H119	6	3	H39	8--7	G-182	G-142
1--70	17	H118	6	3	H38	8--6	G-181	G-141
1--69	20	H117	6	3	H37	8--5	G-180	G-140
1--68	12	H116	6	3	H36	8--4	G-179	G-139
1--67	11	H115	6	3	H35	8--3	G-178	G-138
1--66	13	H114	6	3	H34	8--2	G-176	G-137
1--65	14	H113	6	3	H33	8--1	G-175	G-136

**Table 19– Cin:Apse connector #1 (left-hand) / #8 (right-hand) pin to color link map**

## 10. Time Multiplexing of Fiber Data onto Serial Links

Every beam crossing (132 nsec) the discriminator output pins of the MCMs present 544 bits of threshold detection data which must be shipped to the Digital Boards before the next beam crossing. This is accomplished using LVDS serial links that run at approximately 1.5 Gbit per second. The LVDS transmitter takes a 28 bit parallel data word every tick of the 53 MHz clock and ships that packet serially during the next 18.9 nsec.

Referring back to Figure 3, the Front End board must drive certain sets of bits onto certain links dependent upon whether it has been inserted as the 'left-hand' or the 'right-hand' board. This is accomplished by having two different sets of four links laid into the PCB traces of the Front End board, but only putting components into one of them. When the board is inserted as the 'left-hand' board it must multiplex the data from the MCMs onto the Red, Blue, Yellow and 2<sup>nd</sup> Red links; when inserted as the 'right-hand' board, the data must be presented onto the Purple, Orange, Green and 2<sup>nd</sup> Green. The 2<sup>nd</sup> Red and 2<sup>nd</sup> Green are literal duplicates of the Red and Green, and so require no extra logic; whatever bits are presented to the one LVDS driver are presented to the other at the same time.

Each link may send seven 28-bit words during the 132 nsec. To implement this time division, small programmable logic devices are used to pick off the necessary MCM outputs and multiplex them to the LVDS drivers. Tables 12, 13 and 14 give the order in which the fibers are delivered in the 'left-hand' orientation, while tables 15,16 and 17 describe the 'right-hand' order.

A moment's reflection on the structure of the Front End board suggests that for layout, the CPLDs which multiplex the data onto the Red links should be similar to those driving the Purple links. If one mentally overlays the pattern of Red fibers in Figure 3 over the Right-Hand section of the diagram, it is seen that the Red MCM channels mate in varying degrees to Purple, Orange and Green channels. However, the largest match is between the Red and the Purple. Similarly, the best sharing of resources for the other colors is Yellow/Green and Orange/Blue. This determines how the links wire up on the Front End board. Along the left edge of the PCB, as viewed from the component side, will be links for Green, Green(2), Orange and Purple. Along the right edge of the board, viewed from the component side, will be Red, Red(2), Blue and Yellow.

## 10.1. Left-Handed Fiber Order

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	B50	B49	B64	B63	B62	B61	B60	B59	B58	B57	B56	B55	B54	B53	B52	B51	A37	A38	A39	A40	A41	A42	A43	A44	A45	A46	A47	1
2	A48	A49	A50	A51	A52	A53	A54	A55	A56	A57	A58	A59	A60	A61	A62	A63	A64	C82	C81	C80	C79	C78	C77	C76	C75	C74	C73	0
3	C72	C71	C70	C69	C68	C67	C66	C65	C96	C95	C94	C93	C92	C91	C90	C89	C88	C87	C86	C85	C84	C83	B65	B66	B67	B68	B69	0
4	B70	B71	B72	B73	B74	B75	B76	B77	B78	B79	B80	D112	D111	D110	D109	D108	D107	D106	D105	D104	D103	D102	D101	D83	D84	D85	D86	0
5	D87	D88	D89	D90	D91	D92	D93	D94	D95	D96	D97	D98	D99	D100	E128	E127	E126	E125	E105	E106	E107	E108	E109	E110	E111	E112	E113	0
6	E114	E115	E116	E117	E118	E119	E120	E121	E122	E123	E124	F144	F143	F142	F141	F140	F139	F138	F137	F136	F135	F134	F133	F127	F128	F129	F130	0
7	F131	F132	G158	G157	G156	G155	G160	G159	H176	H175	PSN32	PSN31	PSN30	PSN29	PSS32	PSS31	PSS30	PSS29	PSN29	PSN30	PSN31	PSN32	PSS29	PSS30	PSS31	PSS32	spare	0

Table 20– Data Sent on Red Links by Left-Hand Insertion of Board

When the Front End board is inserted in the ‘left-hand’ position, 188 fibers are transmitted every crossing over the Red links. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information.

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	F107	F108	F109	F110	F111	F112	F113	F114	F115	F116	F117	F118	F119	F120	F121	F122	F123	F124	F125	F126	G154	G153	G152	G151	G150	G149	G148	1
2	G147	G146	G145	G144	G143	G142	G141	H112	H111	H110	H109	H108	H107	H106	H105	G109	G110	G111	G112	G113	G114	G115	G116	G117	G118	G119	G120	0
3	G121	G122	G123	G124	G125	G126	G127	G128	G129	G130	G131	G132	G133	G134	G135	G136	G137	G138	G139	G140	H162	H161	H160	H159	H158	H157	H156	0
4	H155	H154	H153	H152	H151	H150	H149	H148	H147	H146	H145	H174	H173	H172	H171	H170	H169	H168	H167	H166	H165	H164	H163	H113	H114	H115	H116	0
5	H117	H118	H119	H120	H121	H122	H123	H124	H125	H126	H127	H128	H129	H130	H131	H132	H133	H134	H135	H136	H137	H138	H139	H140	H141	H142	H143	0
6	H144	PSN28	PSN27	PSN26	PSN25	PSN24	PSN23	PSN22	PSN21	PSS28	PSS27	PSS26	PSS25	PSS24	PSS23	PSS22	PSS21	PSN21	PSN22	PSN23	PSN24	PSN25	PSN26	PSN27	PSN28	PSS21	PSS22	0
7	PSS23	PSS24	PSS25	PSS26	PSS27	PSS28	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	stat	0

Table 21 – Data Sent on Blue Link by Left-Hand Insertion of Board

When the Front End board is inserted in the ‘left-hand’ position, 168 fibers are transmitted every crossing over the Blue link. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information. The 20 bits marked ‘stat’ are reserved for Front End board status and/or message passing from the Front End board to the Digital board.

**Data sorted by Fiber Number**

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	B48	B47	B46	B45	B44	B43	B42	B41	B40	B39	B38	B37	B36	B35	B34	B33	A33	A34	A35	A36	C49	C50	C51	C52	C53	C54	C55	1
2	C56	C57	C58	C59	C60	C61	C62	C63	C64	E70	E69	E68	E67	E66	E65	E88	E87	E86	E85	E84	E83	E82	E81	E80	E79	E78	E77	0
3	E76	E75	E74	E73	E72	E71	D65	D66	D67	D68	D69	D70	D71	D72	D73	D74	D75	D76	D77	D78	D79	D80	D81	D82	F78	F77	F76	0
4	F75	F74	F73	F72	F71	F70	F69	F68	F67	F66	F65	F96	F95	F94	F93	F92	F91	F90	F89	F88	F87	F86	F85	F84	F83	F82	F81	0
5	F80	F79	E89	E90	E91	E92	E93	E94	E95	E96	E97	E98	E99	E100	E101	E102	E103	E104	G86	G85	G84	G83	G82	G81	G104	G103	G102	0
6	G101	G100	G99	G98	G97	G96	G95	G94	G93	G92	G91	G90	G89	G88	G87	F97	F98	F99	F100	F101	F102	F103	F104	F105	F106	H104	H103	0
7	H102	H101	H100	H99	H98	H97	G105	G106	G107	G108	PSS18	PSS17	PSN20	PSN19	PSN18	PSN17	PSS20	PSS19	PSN17	PSN18	PSN19	PSN20	PSS17	PSS18	PSN19	PSS20	0	0

**Table 22 – Data Sent on Yellow Link by Left-Hand Insertion of Board**

When the Front End board is inserted in the ‘left-hand’ position, 188 fibers are transmitted every crossing over the Yellow link. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information.

## 10.2. Right-Handed Order

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	B18	B17	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B32	B31	B30	B29	B28	B27	B26	B25	B24	1
2	B23	B22	B21	B20	B19	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	0
3	A23	A24	A25	A26	A27	A28	D2	D1	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	C1	C2	C3	C4	C5	0
4	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	0
5	E6	E5	E4	E3	E2	E1	E24	E23	E22	E21	E20	E19	E18	E17	E16	E15	E14	E13	E12	E11	E10	E9	E8	E7	D17	D18	D19	0
6	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	F14	F13	F12	F11	F10	F9	F8	F7	F6	F5	F4	F3	F2	F1	F18	F17	0
7	F16	F15	G6	G5	G1	G2	G3	G4	H2	H1	PSS2	PSS1	PSN4	PSN3	PSN2	PSN1	PSS4	PSS3	PSN1	PSN2	PSN3	PSN4	PSS1	PSS2	PSS3	PSS4	spare	0

Table 23 – Data Sent on Green Links by Right-Hand Insertion of Board

When the Front End board is inserted in the ‘right-hand’ position, 188 fibers are transmitted every crossing over the Green links. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information.

Data sorted by Fiber Number

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	F32	F31	F30	F29	F28	F27	F26	F25	F24	F23	F22	F21	F20	F19	G22	G21	G20	G19	G18	G17	G16	G15	G14	G13	G12	G11	G10	1
2	G9	G8	G7	G40	G39	G38	G37	G36	G35	G34	G33	G32	G31	G30	G29	G28	G27	G26	G25	G24	G23	F33	F34	F35	F36	F37	F38	0
3	H14	H13	H12	H11	H10	H9	H8	H7	H6	H5	H4	H3	H32	H31	H30	H29	H28	H27	H26	H25	H24	H23	H22	H21	H20	H19	H18	0
4	H17	H16	H15	G41	G42	G43	G44	G45	G46	G47	G48	G49	G50	G51	G52	H72	H71	H70	H69	H68	H67	H66	H65	H33	H34	H35	H36	0
5	H37	H38	H39	H40	H41	H42	H43	H44	H45	H46	H47	H48	H49	H50	H51	H52	H53	H54	H55	H56	H57	H58	H59	H60	H61	H62	H63	0
6	H64	PSN12	PSN11	PSN10	PSN9	PSN8	PSN7	PSN6	PSN5	PSS12	PSS11	PSS10	PSS9	PSS8	PSS7	PSS6	PSS5	PSN5	PSN6	PSN7	PSN8	PSN9	PSN10	PSN11	PSN12	PSS5	PSS6	0
7	PSS7	PSS8	PSS9	PSS10	PSS11	PSS12	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	spare	0

Table 24 – Data Sent on Orange Link by Right-Hand Insertion of Board

When the Front End board is inserted in the ‘right-hand’ position, 168 fibers are transmitted every crossing over the Orange link. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved for link synchronization information. The 20 bits marked ‘stat’ are reserved for Front End board status and/or message passing from the Front End board to the Digital board.

**Data sorted by Fiber Number**

Slice	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15	Bit 16	Bit 17	Bit 18	Bit 19	Bit 20	Bit 21	Bit 22	Bit 23	Bit 24	Bit 25	Bit 26	Bit 27	Bit 28
1	A29	A30	A31	A32	C48	C47	C46	C45	C44	C43	C42	C41	C40	C39	C38	C37	C36	C35	C34	C33	D64	D63	D62	D61	D60	D59	D58	1
2	D57	D56	D55	D54	D53	D31	D32	D33	D34	D35	D36	D37	D38	D39	D40	D41	D42	D43	D44	D45	D46	D47	D48	D49	D50	D51	D52	0
3	E64	E63	E62	E61	E25	E26	E27	E28	E29	E30	E31	E32	E33	E34	E35	E36	E37	E38	E39	E40	E41	E42	E43	E44	E45	E46	E47	0
4	E48	E49	E50	E51	E52	E53	E54	E55	E56	E57	E58	E59	E60	F39	F40	F41	F42	F43	F44	F45	F46	F47	F48	F49	F50	F51	F52	0
5	F53	F54	F55	F56	F57	F58	F59	F60	F61	F62	F63	F64	G80	G79	G78	G77	G53	G54	G55	G56	G57	G58	G59	G60	G61	G62	G63	0
6	G64	G65	G66	G67	G68	G69	G70	G71	G72	G73	G74	G75	G76	H82	H81	H80	H79	H78	H77	H76	H75	H74	H73	H96	H95	H94	H93	0
7	H92	H91	H90	H89	H88	H87	H86	H85	H84	H83	PSN16	PSN15	PSN14	PSN13	PSS16	PSS15	PSS14	PSS13	PSN13	PSN14	PSN15	PSN16	PSS13	PSS14	PSS15	PSS16	0	0

**Table 25 – Data Sent on Purple Link by Right-Hand Insertion of Board**

When the Front End board is inserted in the ‘right-hand’ position, 168 fibers are transmitted every crossing over the Purple link. On each of seven 53 MHz clocks 28 bits of data are loaded into the LVDS drivers by a programmable logic device, following the table above. In all seven time slices, bit 28 is reserved and may be used for link synchronization information.

### 10.3. Status and Synchronization Information

Bit 28 of all links is used for link synchronization in all links. The first timeslice is marked by bit 28 equal to '1', and bit 28 is a '0' in all other timeslices. For the Orange and Blue links, 20 other bits in timeslice 7 are available for status and trigger information. These status bits provide a mix of SVX, Front End and Trigger information, all of which may be used by the Digital Board for conditional processing of data. Table 18 gives the breakdown.

Bit Position in Timeslice 7	Name	Interpretation if set (1)
7	HDI_EN	SVX Sequencer thinks SVX chips are being used
8	FIRST_CROSSING	SVX Sequencer timing bit, used to indicate first crossing in a bunch.
9	SYNC_GAP	Beam Gap; data may be diagnostic in nature
10	MCM_STAT0	MCM #0 power is on
11	MCM_STAT1	MCM #1 power is on
12	MCM_STAT2	MCM #2 power is on
13	MCM_STAT3	MCM #3 power is on
14	MCM_STAT4	MCM #4 power is on
15	MCM_STAT5	MCM #5 power is on
16	MCM_STAT6	MCM #6 power is on
17	MCM_STAT7	MCM #7 power is on
18	FAKE_DATA	Front End CPLDs are sending diagnostic patterns, not real data
19	DAC_UPDATE	Front End microcontroller is changing MCM DAC parameters
20	ADC_READ	Front End microcontroller is performing A/D conversions; noise floor may be different
21	LOCAL_CRYO	Front End microcontroller is controlling cryostat temperature; if not set, assume external controller.
22	CRYO_ERROR	Only valid if LOCAL_CRYO is set. If both this bit and LOCAL_CRYO are set, Front End microcontroller has determined that VLPCs are running at improper temperature and data is likely to be invalid.
23-25	FINE_TIMING	3-bit code indicating time offset, in 53MHz ticks, between CROSSING and when this data was loaded – for use in system timing analysis.
26	L1 ACCEPT	Level 1 Accept signaled by SVX Sequencer
27	CFT_RESET	CFT RESET from SVX Sequencer

Table 26